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ABSTRACT

This guide (developed in response to a mandate from the Iowa General Assembly) is designed to help faculties and administrators in developing curriculum and improving instruction in higher order thinking skills. The guide synthesizes the varied and not always consistent ideas about thinking into an approach that will be useful to educators as they work to infuse higher order thinking into their teaching. The guide includes sections on general strategies for teaching thinking, explicit skills-based thinking instruction, and analyzing and evaluating the curriculum. The guide also contains an extensive bibliography with sections on essential references, professional materials, and staff development materials. Eight appendixes including a thinking skills checklist, a scale for rating effectiveness in developing thinking skills, a glossary of terms, and a list of classroom materials and resources available are attached. (MS)

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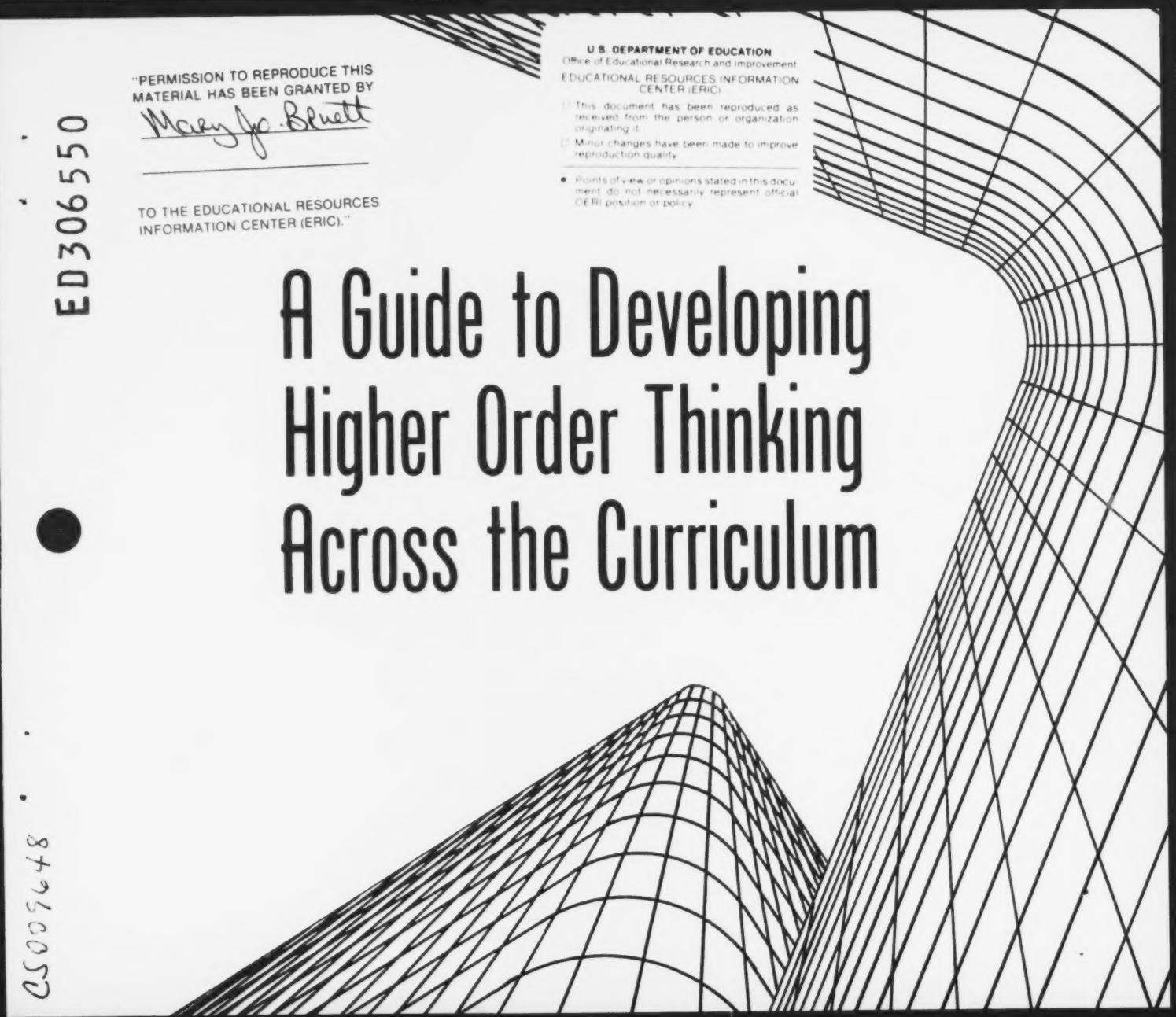
A Guide to Developing Higher Order Thinking Across the Curriculum



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Iowa Department of Education

A Guide to Developing Higher Order Thinking Across the Curriculum

Iowa Department of Education
April 1989

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Contents

Foreword	1
Acknowledgments	3
Introduction and Rationale	5
General Strategies for Teaching Thinking	10
Explicit Skills Based Thinking Instruction	12
I. Content/Basic Thinking	17
II. Critical Thinking	18
III. Creative Thinking	27
IV. Complex Thinking Processes	35
Analyzing and Evaluating the Curriculum	44
Bibliography	49
Essential References: A Place To Begin	49
Professional Materials	50
Staff Development Materials	58
Appendices	67
Appendix A - Incorporating Higher Order Thinking in Curricular Areas	69
Appendix B - Scope and Sequence within a Discipline or Grade Level	72
Appendix C - A Thinking Skills Checklist	75
Appendix D - Classroom Observation Checklist	77
Appendix E - Self-Reflection on Your Teaching: A Checklist	79
Appendix F - How Thoughtful Are Your Classrooms?	80
Appendix G - Glossary	81
Appendix H - Classroom Materials and Resources	83

Foreword

This guide is the result of a 1985 mandate from the Iowa General Assembly, calling for the Department of Education to develop "subject matter committees and committees that cross subject matter lines for coordination of curriculum at all education levels."

This mandate was a response to one of the major recommendations of the Legislature's Excellence in Education Task Force report of 1984, First in the Nation in Education (FINE). The Department of Education based its plan for implementing the legislation on recommendations from the report.

In 1986, the first response to the mandate was published in the form of six guides to curriculum development in the areas of arts, foreign language, language arts, mathematics, science, and social studies. This series focused on vertical articulation of curriculum in the subject matter.

This publication, along with others in this second phase of the effort, focuses on horizontal articulation across subject areas. It is designed to guide faculties and administrators in developing curriculum and improving instruction in higher order thinking skills. It is intended to help districts enhance and build upon their current local curriculum.

Acknowledgments

The Steering Committee for the Horizontal Articulation Curriculum Development Project addressed the task in a milieu that required an extraordinary commitment of time and talent by those who would undertake writing and reviewing assignments. We want to thank those people for sharing their personal and professional resources so graciously and generously. We commend them for their efforts to help us understand and articulate student competencies in higher order thinking across the curriculum.

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Introduction and Rationale

This guide synthesizes the varied and not always consistent ideas about thinking into an approach that will be useful to Iowa educators as they work to infuse higher order thinking into their teaching.

This approach synthesizes the main ideas of many thinkers. Many subtle distinctions and significant details have been sacrificed to the goal of creating a clear framework broadly applicable to the grade levels and academic disciplines in Iowa schools. The guide can serve as a starting point on the road to higher levels of thinking for Iowa teachers and their students.

Purpose and Organization of this Guide

This guide can serve as a starting point on the road to higher levels of thinking for Iowa teachers and their students.

Purpose. To help local districts meet the new school improvement goals required by recent legislation, the Iowa Department of Education has developed a number of curriculum guides. The first set, published in 1986, were guides to the basic subject areas of language arts, math, science, social studies, arts, and foreign languages. They are for schools to use as they write their K-12 curricula in each discipline. In addition to planning careful, sequential progression (vertical articulation) for each subject, districts are required to ensure that certain broad interdisciplinary processes—including communicating, learning to learn, higher order thinking, career education, and multicultural, nonsexist education—are built (or horizontally articulated) into all curricula.

Components. This guide is intended to assist districts with the horizontal articulation of higher order thinking in their total curriculum. The goal is to give educators a sense of:

—what is meant by higher order thinking
—what its components are
—some teaching strategies for developing this thinking in students
—some ways of assessing to what extent a district's instruction and curriculum promote growth in student thinking. Also included is a list of resources for further reading, staff development, and classroom application.

Organization. This guide starts with a broad definition of higher order thinking. Some general strategies for fostering student thinking follow. Next comes a detailed analysis of thinking with explicit, skills based instructional strategies. The last section describes assessment approaches for the general, holistic thinking approach and for the more analytic explicit skills instruction. Thus a school staff or individual teachers can start using the general "teaching for thinking" approaches immediately as they study and make decisions about the more formal analytic approach. In this way, teaching thinking will start as a manageable task, not an overwhelming burden consisting of a long list of specific skills to be understood, sequenced, and taught. For this reason the details of our definition of higher order thinking—the specific skills and processes—come relatively late in the guide.

Assumptions about Teaching Thinking

The improvement of thinking is not susceptible to quick fix approaches.

As with most topics in education, different authors advocate different approaches to developing thinking in students. Rather than a detailed discussion of the various issues about the teaching of thinking, included is a list of claims that have strong support in the literature, although not every theorist would agree with all of them. Discussing these assumptions and their implications for curriculum and teaching is a good starting activity for a school's thinking skills committee.*

Thinking abilities can be developed.

Efforts to improve thinking should involve all students.

Due to the developmental nature of thinking abilities, the improvement of thinking should be addressed throughout the grades and should begin in primary classrooms.

Thinking is fundamental to learning in all subjects and therefore should be addressed in all content areas.

Teaching for thinking within content areas improves the quality of student thinking and promotes deeper understanding of content material.

Efforts to improve student thinking should include explicit instruction in thinking skills. It cannot be assumed that thinking will develop automatically as a by-product of other activities.

Current standardized tests do not adequately assess higher order thinking skills. Both quantitative and qualitative methods should be used in assessment.

Teachers who think develop students who think. Thinking teachers are the best teachers of thinking skills.

Change takes time. The improvement of thinking is not susceptible to "quick fix" approaches. Significant results will require thoughtful, long-range planning and sustained commitment.

Cooperative learning exchanges enhance the quality of thinking and learning.

Consideration must be given to the affective environment within a classroom for students to effectively learn thinking skills.

Metacognition, or thinking about one's own thinking, is an integral part of a comprehensive thinking skills program.

Teachers should be respected as thinkers and should be involved in professional planning, decision making, and problem solving.

* *Adapted from: Jay McTighe, "Ten Assumptions Regarding the Teaching of Thinking," in Improving the Quality of Student Thinking, Maryland State Department of Education, June 1985.*

Definition as Model or Framework

Definitions. The thinking skills literature contains many definitions of higher order thinking corresponding to the interests or points of reference of different researchers. This guide formulates a comprehensive definition that includes the varied processes and purposes referred to as higher order thinking and depicts the relationships among these processes and purposes. For clarity and ease of recall, the definition is presented graphically. A general view of the model is given in this section. More detailed views of specific parts come later in the guide.

Nature of the model. Definitions and models have specific purposes. This one is a guide or framework for developing curriculum and instruction. It is not a model of how the mind or brain works or how mental functioning develops in individuals. It is a map of the territory of thinking, to be used by teachers and students as they teach and learn thinking, serving as a "big picture" to keep in mind while working with specific parts. It is not the only possible pedagogical map, but it provides a reasonable balance between comprehensiveness and manageability. This representation serves the functions of models defined by the authors of *Dimensions of Thinking*. It acts as "an organizing framework—a latticework to unite the many and varied approaches [to teaching thinking], one which would allow the practitioner to judge the extent to which a particular program embraces all the important areas in the teaching of thinking." (p. 3)

The Integrated Thinking Model. This name emphasizes that thinking is not a mere collection of separate skills but an interactive system. While it is convenient for teaching and learning purposes to divide the territory of thinking into provinces, actual experiences of thinking consist of dynamic and fluid combinations of many different mental operations aimed at varied purposes and based in knowledge and values.

The graphic representation of the Integrated Thinking Model (ITM), shown in Figure 1, depicts these different aspects of thinking and their interrelationships. The central triangle represents "Complex Thinking"—the goal-directed, multi-step, strategic processes such as designing, decision making, and problem solving. This is the essential core of higher order thinking, the point at which thinking intersects with or impinges on action. That is, people engage in complex thinking in order to do something they need or want to do. Complex thinking exists at some level of sophistication in all individuals, from young children almost instinctively solving the problem of how to get their mothers' attention to the highly rational and formal decision making strategies used by trained professionals.

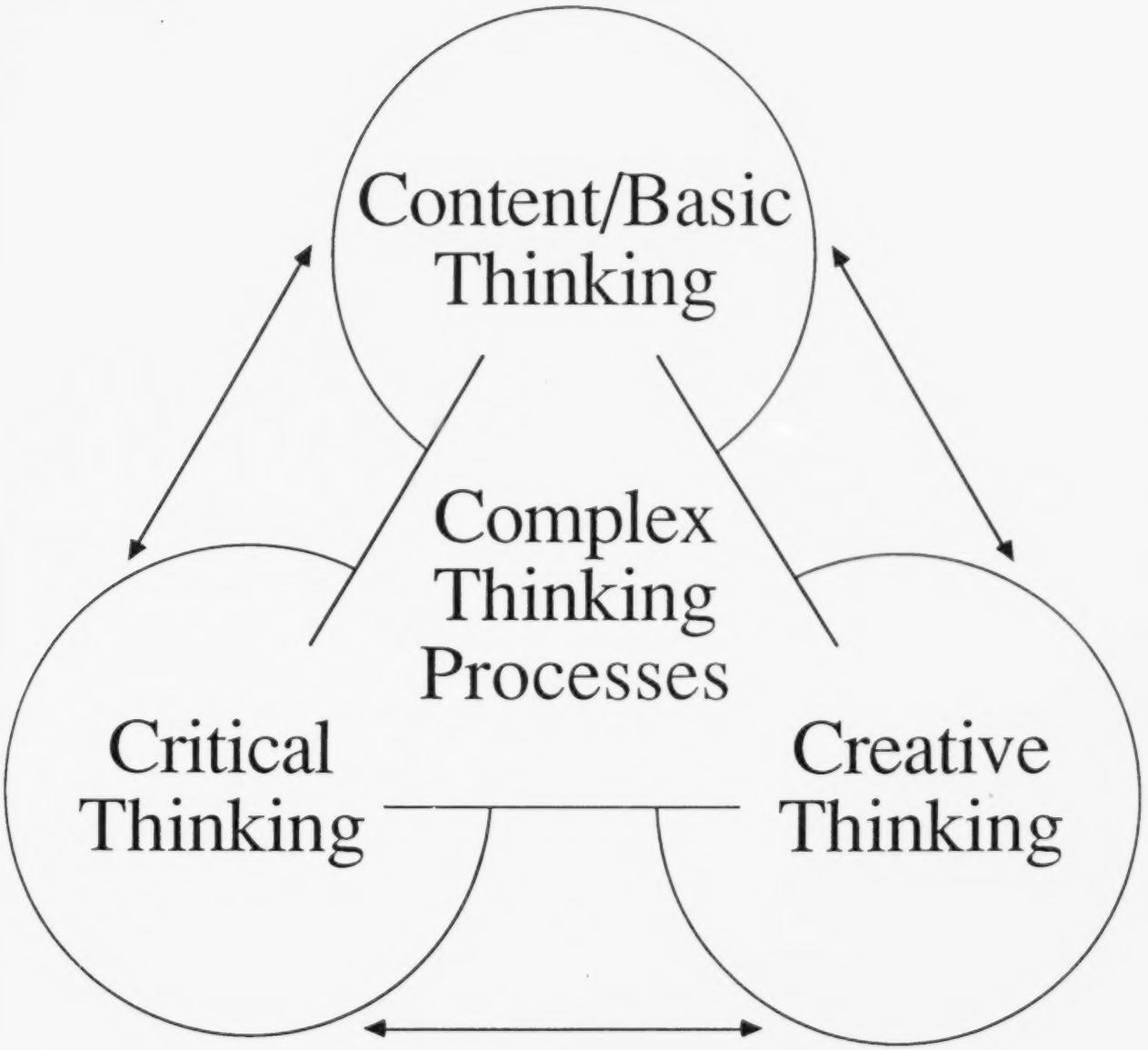
Thinking is not a mere collection of separate skills but an interactive system.

Surrounding the complex thinking core are three circles representing the basic categories or provinces of thinking that support and interact with the complex thinking processes. The top circle, labeled "Content/Basic Thinking," represents the skills, attitudes, and dispositions required to learn accepted information—basic academic content, general knowledge, "common sense,"—and to recall this information after it has been learned. Content/basic thinking thus includes the processes both of learning and of retrieving what is learned.

The other two categories, represented by the circles labeled "Critical Thinking" and "Creative Thinking," differ from content/basic thinking in that they involve acting on or transforming the information rather than just absorbing and remembering it. Critical thinking behaviors involve reorganizing in meaningful ways the "accepted knowledge" from the content/basic thinking; creative thinking involves using and going beyond the accepted and reorganized knowledge to generate new knowledge.

The arrows and the open corners of the central triangle represent the interaction and lack of absolute boundaries between the provinces of thinking. When thinking critically or

Figure 1: INTEGRATED THINKING MODEL:
Overview



creatively, a person often uses content/basic thinking to recall pertinent information, and learning accepted knowledge (or what is generally called "content") is often strengthened by thinking about it critically or creatively. And the complex thinking processes make use of all three types of thinking—learning and recalling, reorganizing, and going beyond accepted knowledge. Children, for example, remember getting attention in the past by whining (content thinking), infer that the scolding they got was also caused by whining (critical thinking), and use flexible thinking to think of better ways to get attention (creative thinking).

Later in this guide, the Integrated Thinking Model will be presented in detail, with each of the four provinces analyzed into skills or operations that can be taught separately and directly. First, however, some more general, holistic approaches to teaching thinking will be discussed.

General Strategies for Teaching Thinking

Classroom interactions must communicate the cognitive spirit.

One of the issues in the thinking skills movement is whether thinking must be explicitly taught or whether it is simply a result of good teaching in the various content areas. Arthur Costa, for example, sheds light on this question by talking about teaching for, of, and about thinking. Teaching *for* thinking refers to teaching basic subject matter by providing activities, assignments, and expectations that require and empower students to use thinking skills. Teaching *of* thinking means directly teaching students what a specific thinking skill or process is and how to do it. Teaching *about* thinking involves guiding students to observe their mental processes as they think and to become aware of the different thinking styles of individuals and of the typical knowledge-producing processes of various academic and creative domains, (e.g., how a choreographer thinks while designing a dance or how a sociologist develops new explanations of social problems.)

Teaching for thinking, then, refers to the general strategies that good teachers have always used to stimulate students to think. Several broad approaches that are extremely important for all types of teaching thinking are establishing a classroom climate for thinking, modeling the behaviors of a thinker, using appropriate questioning styles, and planning student assignments and assessments.

***A classroom climate which encourages students to think exists when teacher/student interactions clearly:**

1. value all students as persons capable of contributing to discussions and of improving as thinkers
2. value diversity of thought and thinking styles
3. provide for cooperative as well as individual thinking
4. communicate what Arthur Costa (1985) calls the cognitive spirit and Robert Ennis (Baron 1987) calls the dispositions of critical thinkers: open mindedness, seeking for reasons, striving to be clear, precise, and well informed, and having "sensitivity to the feelings, level of knowledge, and concerns of others." (Costa 1985, p. 68)

***Modeling the behaviors of the thinker means teachers should seek to demonstrate the cognitive spirit as consistently as possible.** They should take every opportunity to think about problems, to avoid jumping to conclusions, to revise their opinions when the evidence warrants, to show how ideas relate to each other, and so on. Teachers also should frequently think aloud through difficult or non-routine problems to show students that problem solving is not magical and to demonstrate strategies for dealing with difficulties.

***Teachers must also understand the questioning style appropriate to eliciting student thinking.** Unlike the rapid-paced questioning advocated for drill and recitation, thinking requires a questioning style characterized by a longer wait after questions to give students a chance to form thoughtful answers. Teachers should start with a broad, provocative question, accept a number of responses from different students, ask follow up questions which require students to elaborate, justify, or clarify their original responses, and encourage students to direct questions and responses to each other. Cooperative learning techniques have been praised by many researchers as conducive to higher order thinking by students.

***Student assignments should require students to think,** both by applying the thinking skills and processes taught, and by responding to unstructured, open-ended assignments where they must marshal their thinking abilities to plan and carry out extended thinking. Teachers will need to critically examine textbook exercises and modify them if necessary to ensure the best balance of the different types of thinking for their teaching situation. Since many texts are heavily weighted with recall and oversimplified application questions, textbook selection committees will want to check for thinking assignments. One writer on textbook selection suggests examining all activities in textbooks in terms of whether the type of thinking they require will help the students. (Muther 1987)

***Test questions and other student evaluation tools should also require thinking from students.** Well designed multiple choice questions can pinpoint specific types of thinking, while essay questions can reveal a student's active control of a variety of types of thinking. As with textbooks, standardized and other non-teacher prepared tests should be examined to see what thinking skills and processes are elicited.

Most educators would agree that these general "teaching for thinking" behaviors are important. Indeed, they are necessary preconditions for nurturing the development of student thinking. Although these strategies are well known and often advocated, most faculties could benefit from assessing their current use, deciding if more implementation is needed, and then making a focused effort to do so. Useful staff development activities are:

—sharing specific things teachers can do to establish a thinking climate

—practicing and coaching each other in questioning styles

—working together to critique and modify student assignments and evaluations.

This holistic approach to teaching thinking has several advantages compared to a skills-based approach. The general strategies can be used whether or not the teacher or students have an analytic definition of thinking. That is, they need not be able to specify the component skills of thinking or describe them operationally. In addition, this holistic approach builds on abilities and dispositions already present in children, thus refining activities children are intrinsically motivated to do. These broad approaches are crucial to fostering the disposition to think and the confidence that thinking is possible and important. Without the general approach, more explicit, analytic teaching may lead students to "perform" thinking as a classroom exercise without ever internalizing thinking as an important and valued life activity. For these reasons, a good approach is to start by understanding, practicing, and refining these general strategies and then gradually planning and implementing an explicit skills-based component to complement but not supplant the holistic approach.

Explicit Skills-Based Thinking Instruction

Holistic Approach Compared to Explicit Skills Approach

The holistic approach to teaching thinking means arranging curriculum and instruction so that students have the need and the encouragement to use their thinking abilities and have models from which to learn. The explicit skills-based approach is often contrasted with the holistic, or general, approach. The general strategies approach is comparable to Costa's teaching for thinking, while the explicit skills approach corresponds to his teaching of and about thinking. It involves analyzing thinking into specific, teachable skills that can be explained to students as step-by-step procedures and taught by conventional skills teaching techniques. It also involves increasing student awareness of what they and others are doing as they engage in thinking.

While the general method is valuable in many situations, it cannot be the only approach to helping all students become skillful and flexible thinkers. Returning to the comparison of problem solving by young children and by professionals, clearly the children's natural problem solving, though often effective, is much more limited than that of a management team involved in strategic planning or highly structured decision-making techniques. Students eventually need to master many of these powerful, though less intuitive, thinking processes. Such formal techniques usually require direct skills instruction; people seldom develop them naturally.

The goal in teaching thinking to students is to build on their existing abilities and self-confidence, to expand their repertoire of thinking techniques and their understanding of when different types of thinking are useful, and to help them see the value of knowing many ways to think. Through holistic teaching they learn they are valued as thinkers, gain experience in devising their own complex thinking patterns and observing those of other people, and absorb new skills by observing models and refining their own practices. Explicit skills teaching complements the holistic approach by giving direct instruction in specific skills and concepts, including definitions, guided and independent practice, and applications. Explicit skills teaching is a way to teach students processes and techniques that they have not constructed on their own from their experiences in holistic learning situations.

Requirements for Using Explicit Skills

Teachers using the holistic approach need positive attitudes toward students as developing thinkers and an understanding of the general strategies required by the holistic approach. For teachers using the explicit skills approach, several additional elements are required. These include:

1. A more detailed map of the territory of thinking, showing the breakdown of the four general areas into skills and processes defined in behavioral terms (what one actually does when performing a given skill).

2. A clear sense of how these specific skills interact and work together to make up complex thinking processes (that the skills of evaluating, comparing, imagining, etc., combine to form the process of decision making, for example). This understanding enables teachers to effectively sequence skills instruction and to avoid teaching isolated skills for skills' sake.
3. Model lesson plans for teaching an explicit skill and some guidelines for their use.

The rest of this section of the guide addresses the third element. In the next section, the Integrated Thinking Model, introduced in the Definition section, will be analyzed in detail to address the other two elements above.

A Model Lesson Format for Explicit Thinking Skills Instruction

Though there is no single lesson format for teaching thinking skills explicitly, certain elements should be present in such lessons. The order of these elements depends on how directive or inductive the teacher wants to be in a given situation.

—Definition of the skill: What exactly is the skill?
—Discussion of uses and purposes of the skill: When and why do people use the skill, in what circumstances is it useful?
—A step-by-step description of how to execute the skill: What exactly do you do and in what order?
—Demonstration of the skill: Either the teacher or a student "thinks aloud" an example of using the skill.
—Guided and independent practice by the students: Students use the skill with and without teacher supervision.
—Application of the skill to appropriate content areas: Use the skill with academic content being learned.
—Reflection by students and teacher on experiences using the skill: Students share how they used the skill, what was hard to do, comparison of different approaches, clarification of any confusion.
—Reinforcement of the skill by use in future content application: Use in many different contexts to facilitate transfer.

The goal is spontaneous, appropriate use of thinking skills by the student.

Barry Beyer, in *Practical Strategies for the Teaching of Thinking* (1987), distinguishes between directive and inductive strategies for teaching thinking skills. In a directive lesson, the teacher states the definition, tells the students how to do it, and demonstrates the skill before having the students practice. In inductive lessons, after a brief teacher-provided definition of the skill, the students attempt to perform the skill and then generate their own definitions and descriptions based on what they did. This is followed by a more formal description of the procedure based on the students' and teacher's insights.

One can conceptualize a continuum of teaching strategies from teacher-directed to student-generated, with the directive, explicit skills approach on one end, the inductive lesson somewhere in the middle, and the holistic, general strategy on the other end. The goal is spontaneous and appropriate use of thinking skills and processes by the student. In the directive strategy, the teacher explains exactly what it is the student should do, how to do it, and when it might be used. In the inductive strategy, the teacher explains what the skill is and then gives students the chance to figure out how to do it themselves, concluding with a

jointly developed process description. In the holistic strategy, students are presented with situations in which they must select and apply skills to complex thinking processes like problem solving. In this approach, students focus less on learning a process than on coming up with results. To make an analogy, in teaching fractions in math, the directive strategy would be teaching students a specific method of adding fractions. The inductive strategy would be asking them to figure out ways to add fractions and then discussing their attempts and agreeing on a good method. The holistic strategy would be presenting students the problem of comparing costs of refreshments for different numbers of guests. They would then need to identify adding fractions as a useful strategy, remember how to do so, and know how to combine this step with other strategies.

Researchers suggest several guidelines teachers can follow to decide when to use inductive or directive explicit skills strategies or general, holistic strategies.

—Younger, less skilled thinkers benefit from directive strategies.

—Less confident students often need directive strategies.

—More complex skills may require more directive strategies.

—Capable and more confident students gain more ownership through inductive and holistic strategies.

—Students with their own well established, effective skills and procedures may suffer in achievement when required by directive teaching to adopt a specified procedure.

—The directive strategy requires the teacher to know a step-by-step procedure for a skill; with an inductive strategy students and teacher can "discover" the procedure together.

—The inductive strategy can result in greater retention since students are more involved in learning. By the same token, it may cause retention of weak procedures.

The inductive strategy can result in greater retention since students are more involved in learning.

As with other teaching decisions, teachers must consider the age, abilities, and previous experiences of their students, the nature of the learning tasks, the available learning materials, and the attitudes of the students. As always, different students in a class will profit from different approaches. A practical approach is to provide a balanced diet of explicit and holistic approaches. Specific students' responses to general strategies indicate their need for explicit skills instruction.

An additional consideration regarding explicit skills instruction arises when the frame of reference expands from individual teachers to the entire school. Although it is possible for individual teachers or small groups of teachers to select and sequence explicit skills to teach, a K-12 scope and sequence agreed upon by the total staff is more effective. Such school-wide decision making has the advantage of giving all teachers a common vocabulary and ensures a minimum of duplication and a maximum of consistency and progress over a student's school career. Scope and sequence will be discussed in the Analysis and Evaluation section.

Integrated Thinking Model: Detailed Definition and Strategies

A general definition or framework for the universe of thinking has been presented, which may well be sufficient for teaching thinking using a holistic approach. But in order to use an explicit skills approach, these skills must be defined in enough detail to be explained directly to students. Thus it is necessary to move from a broad definition or map to an analytic view of thinking at the teachable level.

This general definition or framework for the universe of thinking may be sufficient for teaching thinking using a holistic approach. But to use an explicit skills approach, these skills must be defined in enough detail to be explained directly to students. Thus it is necessary to move from a broad definition or map to an analytic view of thinking at the teachable level.

Figure 2 adds one level of detail to the broad map presented earlier by adding a label for the typical knowledge of each province, the usual kind of material produced by that type of thinking. Each province acts upon the curriculum content in a unique way and transforms it into a characteristic type of knowledge (what is learned). "Knowledge" is the stuff of thinking—facts, concepts, principles, systems, skills.

Content/basic thinking deals with accepted knowledge, absorbing and recalling knowledge created by others basic facts, concepts, and principles of the academic disciplines; social rules and conventions; basic skills such as reading or calculating; even common sense. Another component of this province is metacognition, or understanding and managing one's thinking and learning, which is basic to any higher order thinking.

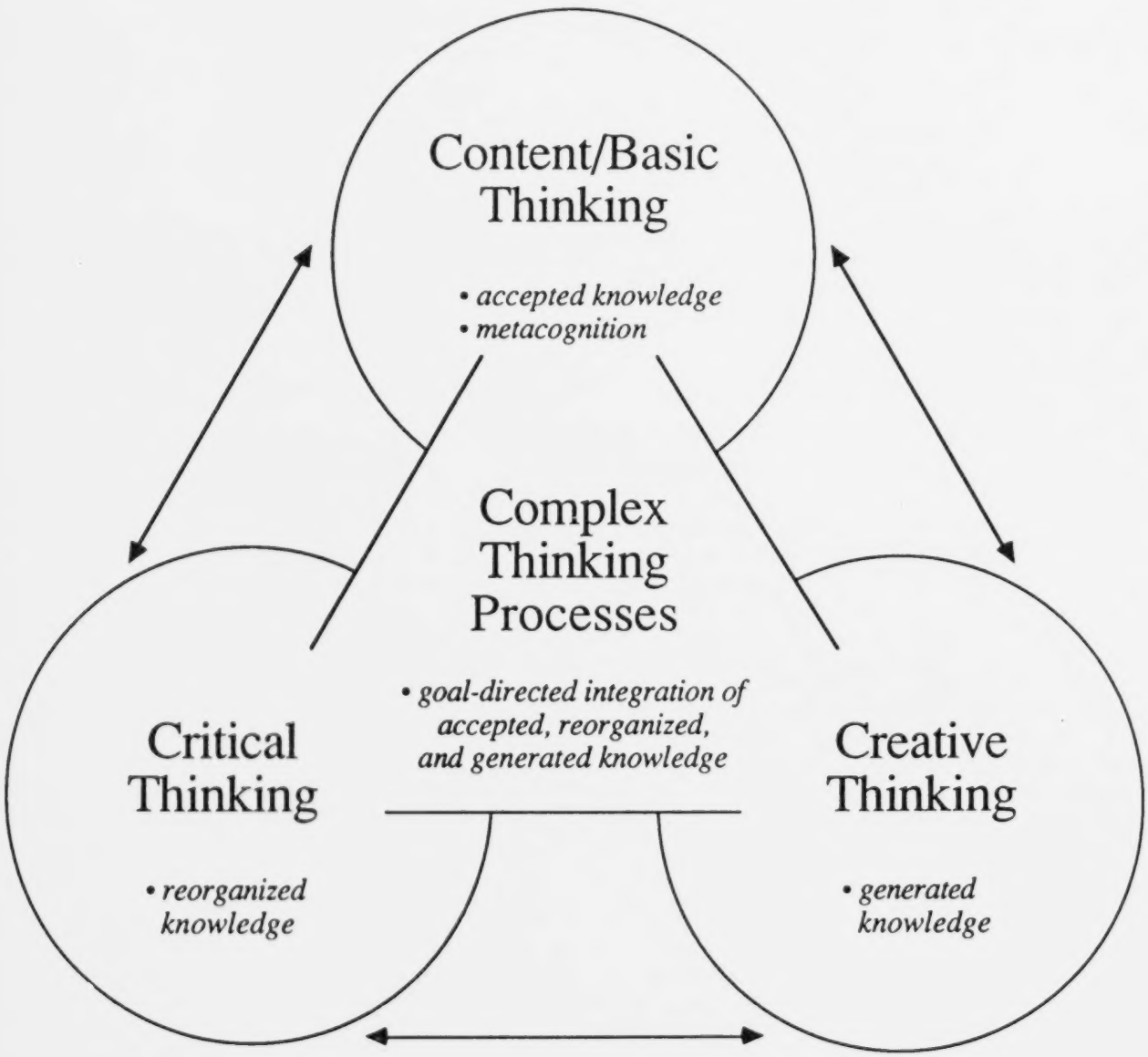
Critical thinking, by analyzing, evaluating, and making connections in accepted knowledge, produces reorganized knowledge.

Creative thinking, by synthesizing, imagining, and elaborating on accepted and reorganized knowledge, produces generated knowledge, ideas that move beyond accepted knowledge to the novel or original.

Complex thinking processes make use of all the other types of thinking to achieve some purpose or produce some outcome—a design, a decision, a solution. Complex thinking integrates accepted, reorganized, and generated knowledge in a goal directed way.

Figure 2: INTEGRATED THINKING MODEL:

Typical Knowledge of Provinces



I. Content/Basic Thinking

The primary function of this province is in learning content, both the academic content taught in schools—facts, skills, concepts, principles, rules, etc.—and the body of social conventions, general knowledge, and practical skills that are basic to functioning in society and to any higher levels of learning and thinking. Content/basic thinking enables individuals to take in essential information from the culture. It is also basic because it includes the skills and behavior patterns that form the basis of learning and thinking most effectively—metacognition.

Although learning content and gaining accepted knowledge is very important, this guide will not cover it in depth, since this type of thinking is the focus of the subject area guides and the horizontal articulation guide on learning. Indeed, absorbing and recalling accepted knowledge is outside the realm of higher order thinking as it is generally understood. There is, of course, constant interaction between content/basic thinking and the three higher order thinking provinces; one must have a certain knowledge base about which to think critically and creatively, and complex thinking often requires thinkers to research accepted knowledge and absorb new content. What is now considered accepted content for schools to pass on to learners was once new knowledge generated by critical, creative, and complex thinking.

Children should learn in science class how scientists think scientifically.

The term "metacognition" often appears in definitions and discussions of higher order thinking. Costa's term, teaching about thinking, refers to the same concept of building students' awareness of how they and others think, including the different thinking modes of the various academic domains. This latter awareness should be developed through subject matter instruction concerning the intellectual systems of the different fields of study. Children should learn in science class how scientists think scientifically, or in writing classes how poets make artistic decisions.

The other part of metacognition falls into the domain of learning-to-learn skills. Robert Marzano (1988) describes this type of metacognition as "being aware of your thinking as you perform specific tasks and then using this awareness to control what you are doing." He delineates metacognition into "knowledge and control of self," which includes "commitment, attitudes, and attention;" and "knowledge and control of task," which comprises "setting goals, planning, correcting for error, and evaluating." These skills are described in detail with suggestions for teaching them to students in the Association for Supervision and Curriculum Development thinking program, TACTICS. Like the accepted knowledge skills of absorbing and recalling, these metacognitive skills are a crucial underpinning of higher order thinking. In-depth treatment of them is outside the scope of this guide. They are, however, developed and exercised through many of the general and explicit skills teaching strategies.

II. Critical Thinking

In the Integrated Thinking Model, the province of critical thinking is divided into three sub-categories which each reorganize knowledge in characteristic ways. They in turn are divided into several skills at the teachable level. These are shown in Figure 3. The categories and their skills include:

Analyzing, defined as separating a whole into meaningful parts and understanding the interrelationships. The skills include:

recognizing patterns
classifying
identifying assumptions
identifying the main ideas
finding sequences.

Connecting, defined as constructing relationships within and between systems. The skills include:

comparing/contrasting
logical thinking
inferring deductively
inferring inductively
identifying causal relationships.

Evaluating, defined as judging based on criteria. The skills include:

assessing information
determining criteria
prioritizing
recognizing fallacies
verifying.

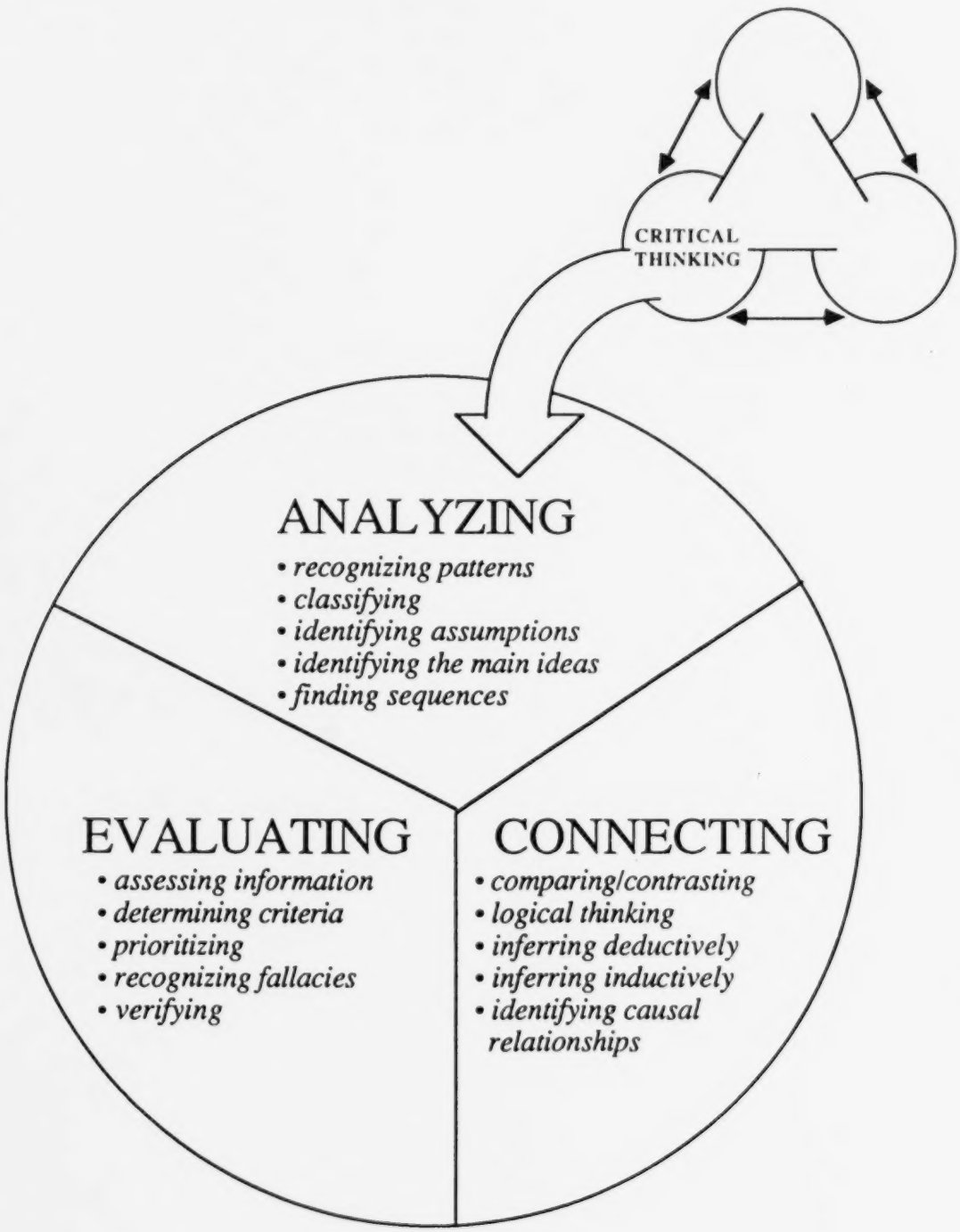
Each of these three sub-categories and its skills will be described further in the rest of this section.

Analyzing

Analyzing involves understanding and manipulating part/whole relationships. In trying to understand a topic, an issue, a work of art, or a situation, it is often useful to break down the whole into smaller parts. These smaller parts are easier to work with, and understanding the whole requires examining how the parts interrelate. For example, understanding the circulatory system means knowing what its parts are (heart, blood vessels, lungs, etc.) and how they work together (blood moves between the organs in specific ways and performs different functions).

Since there are different types of relationships between the parts of wholes, students will need experiences with relationships that are hierarchical (main idea and supporting details), sequential (plot lines, steps in a process), chronological (historical narrative), and in repetitive patterns (musical structure, certain math sequences), among others. Grasping

Figure 3: CRITICAL THINKING PROVINCE:
Detailed View



these relationships is to some extent developmental, as anyone knows who has tried to teach set theory, or even main idea, to first graders. Narrative and sequential patterns seem more accessible to young children than hierarchical or cause and effect relationships. As with all learning, concrete experiences with relationships should come first, then visual representation, and finally abstract symbols. Cuisinaire rods or nesting cups, then pictures of objects, and finally numbers and variables could be used to show the relationship of digits to numerals, for example.

Different types of thinking can be elicited in students by different types of questions. Question stems to cue analyzing include:

What parts can _____ be divided into?

Do you see a pattern in _____ ?

Are there any hidden parts (assumptions) here?

Is _____ organized in some order? What kind?

Next, the five analyzing skills are described and followed by example lesson objectives from different subject areas. Some of these examples come from the Iowa Department of Education Guides to Curriculum Development. Some skills are more relevant to some subjects than to others. They are examples only, and by no means indicate the only subject areas where a skill might be used. In working with this guide, teachers should share and develop their own objectives for the particular content they teach.

Recognizing Patterns. Students will perceive progressively more complex patterns of organization. Starting with simple repetition and recognition of visual or aural patterns, students should gradually master a variety of conventional or repetitive structures in many kinds of organized bodies of material, e.g. texts, works of art, quantitative data, or situations.

Examples:

Arts. Listening to folk song recordings in grade 5, students will recognize song patterns as AABA or verse: refrain.

Language Arts. After reading a number of Italian and English sonnets, students will identify specific sonnets as exemplifying one metric pattern or the other.

Math. As they explore decimal fractions, students will recognize the patterns occurring in the place value names on each side of the decimal point (ones, tens, hundreds, tenths, hundredths...).

Narrative and sequential patterns seem more accessible to young children.

Classifying. Students will learn that elements can be sorted into groups with common attributes (categories). The categories can be labeled to reflect the common attribute. This process helps show how the parts can be grouped in meaningful ways which may help clarify organization.

Examples:

Math. Students will use dot arrays to represent all the factors of given numbers and then classify the numbers as prime or composite. The students will discuss how they arrived at their answers.

Science. The teacher will collect 20-25 objects and ask the students to sort them into groups and name the groups. Students will regroup the set in many different ways. The teacher will explain that this process is called classifying and develop with the students a wall chart showing the steps of classifying.

Social Studies. After reading the Civil Rights Law of 1964, the students will research the reasons used for and against its passage. They will classify the arguments into political, emotional, social, and economic ones. The teacher will then review the process of classification, the difficulties with this particular classification, and compare the rationales different students have for their classifications.

Identifying Assumptions. Students will realize that many assertions, works of art, problem statements, etc., contain hidden parts, underlying suppositions, or beliefs accepted as true without need of support. Since detecting such assumptions requires being able to recognize missing parts—things that are not stated but are implied by other parts of the whole—this is one of the more developmentally advanced skills. Teachers can help younger students by pointing out assumptions in statements made by the teachers and student.

Examples:

Health/Physical Education. Students will analyze tobacco advertisements to identify underlying assumptions that many advertisers use to sell their products (e.g., that smoking makes you popular). This analysis could be extended to other products. Have students collect ads and identify the hidden assumptions.

Math. When given a non-routine problem, students will identify assumed constraints required by the solution (e.g., toothpick problems—can it be two- or three-dimensional?).

Vocational Education. In home economics, students will examine a variety of cookbooks and determine what assumptions they make about the cooking ability and knowledge of their readers. Discuss which features of the different books indicate these assumptions.

Identifying main ideas is advanced, which may explain why primary students find it difficult.

Identifying the Main Ideas. Students will be able to find the central meaning of a passage, a work of art, a set of quantitative data, or a situation. Doing this requires the ability to differentiate the core idea(s) from supporting or extraneous details, which is a hierarchical relationship. For this reason, identifying main ideas is relatively advanced, which may explain why many primary students find it difficult. Teachers can help younger children by asking them what the main idea is of something they've said, and by asking them if something is a main (general) idea or an interesting (but minor) detail.

Examples:

Arts. Students will be able to identify a theme or main idea in a painting and explain how the parts relate to this theme.

Language Arts. After reading a short story or a poem, the students will be able to select the underlying theme and the supporting details. In a group discussion, give students an opportunity to tell how the details support the main idea.

Social Studies. Students will be able to find the main idea from the political cartoons in the daily newspaper. Each week, time will be set aside to look at current news as it is reflected in the cartoons. Students should justify and explain their conclusions.

Finding Sequence. Students will determine the consecutive order of the parts of a sequentially organized body of material. At the simplest level they can order a group of objects from smallest to largest or list the steps in which a simple process is performed. At more sophisticated levels the necessary order of events can be determined even when not presented sequentially—a novel with flashbacks, for instance, or a math problem presented with extraneous information.

Examples:

Foreign Language. In an intermediate German class, students will describe sentences they understand in terms of order of grammatical function, e.g., "Der Mann das Buch gekauft hat" article, noun, article, noun, verb, auxiliary verb. They then should derive the typical sequence for various sentence types; that is, hypothesize rules of syntax.

Vocational Education. The students will read the directions for making a bird house or other object and list the steps of construction in sequence. Students should compare lists and decide if more than one sequence is possible.

Social Studies. Students should study various documents and artifacts from a historical period and try to decide their probable chronological order. They should defend the sequence they support by evidence from the artifacts.

Connecting

While analyzing deals with ways of dividing things perceived as wholes into parts which have interrelationships, connecting focuses on finding or imposing relationships between wholes (or items on the same level of analysis). That is, connecting seeks similarities and differences between comparable things, looks for causes and effects of events or situations, and links together assertions into chains of argument (because certain things are so, other things must be true also).

Connecting builds on analyzing, since to link wholes one often needs to know their attributes or parts. For example, in comparing poems, each poem may be analyzed as to theme, structure, figurative language, etc., and then the respective parts compared.

The developmental range of connecting skills is quite broad. While comparing and contrasting seem natural to children at very young ages ("My house is bigger than yours"), the logical thinking skills can reach very advanced levels (symbolic logic or geometry proofs) that are difficult for many adults. This range should be kept in mind when developing scope and sequence in order to avoid frustration for teachers and students.

Some useful question frames to cue connecting include:

* How is _____ like (or different from) _____?
* What might have caused _____?
* If _____ were the case, what might result?
* If these things are true, what else must be true?
* What is your reason for _____? What evidence supports _____?

The connecting skills and sample objectives follow.

Comparing/Contrasting. Students will note similarities and differences between objects, events, or actions. They may start with simple, global comparisons ("That game is more fun than this one") but should eventually master complex, multi-attribute comparisons, such as comparing two theatrical productions or several business plans.

Examples:

Foreign Language. Elementary students studying Spanish will learn how Christmas is celebrated in Mexico and compare and contrast this with Christmas in the United States.

Science. During a study of animal life, the teacher will explain the use of Venn diagrams and have students apply the technique to compare frogs and toads, alligators and crocodiles, etc.

Science. Students will compare the process by which limestone is formed with the process by which sandstone is formed.

Logical Thinking. Students will learn to apply the rules of logic to analyze and accurately construct a valid argument or conclusion. Logic is not a single skill but a complex

system of skills; it is being treated as an entity here because there are many structured courses of study and materials available to teach it. Students may not master the intricacies of formal logic during their school careers, but they should start early to understand that assertions need support or reasons why they should be believed. Teachers can ask students to give reasons for statements they make; they can also ask them to analyze other people's arguments (assertions and support).

Examples:

Health/Physical Education. After discussions of exercise and its relationship to physical fitness, students will construct arguments to support the thesis that a regular exercise program contributes significantly to physical fitness. Students will then share their arguments and evaluate the logic.

Language Arts. After reading several debates and discussing the pro/con arguments, students will note the logical reasoning presented on both sides. Students should discuss the major premises, assumptions, and conclusions established.

Social Studies. Select several famous political speeches (Churchill, Kennedy, Lincoln, King). After analyzing the speech, abstract the logical arguments from the document. Students should discuss the major and minor premises, conclusions, and assumptions.

Inferring Deductively. Students will learn how to derive logical conclusions from accepted generalizations, truths, or principles. They will come to understand that if certain statements are accepted as true, certain others will necessarily also be true. This skill is a subcategory of logical thinking since it may involve syllogistic reasoning and rules of logical implication, but it seems worth treating separately because it is so important in informal reasoning and argument. This is one of the more developmentally advanced skills, but younger children can begin by understanding rules of games. If a certain rule is in effect and someone breaks it, then what must happen? Somewhat older students can understand the concept of things being true by definition. (For example, "If we define a city as a settlement with more than 2,500 people, then a town of 8,000 must be a city.")

Examples:

Math. Given a set of axioms, students will prove a theorem. Students will then share rationale statements for their strategies and decide whether the proofs are valid.

Vocational Education. According to the economic theories studied in class, deduce the effect of prices of grain products in a year when the U. S. had a bumper crop of grain, reserves are low, and population is decreasing. Compare deductions based on different economic theories.

It is always possible that new observations will make an inductive inference less convincing.

Inferring Inductively. Students will learn how to develop a theory or draw a conclusion from empirical data. That is, after observing natural phenomena, surveying opinions, or studying statistical information, students will develop reasonable explanations or predictions. Unlike deductive inferences, which are logically necessary conclusions, inductive inferences yield probable conclusions. Because they are based on observation, it is always possible that new observations will make an inductive inference less convincing, as the history of science shows.

Examples:

Foreign Language. After reading about customs regarding meal and sleeping times in Spain, students will develop a theory to explain this pattern.

Language Arts. Students will note the dramatic effect mass communications has on consumers. Students will compare television, magazine, and radio advertisements for a given product. Based on their study, they will develop a theory to explain the different persuasion techniques used in the three types of media.

Math. Given information from tables, charts, graphs, and advertisements, students will decide what conclusions may be drawn about the information. They will share their conclusions in group discussion and defend their inferences.

Social Studies. The teacher will present climate graphs and a physical map of a specific region and have students make inferences about the kinds of natural resources, size of cities, and so forth that might exist in the region. Students should share the rationales of their inferences.

Evaluating is not the same as expressing a personal attitude.

Identifying Causal Relationships. Students will be able to suggest causes of an event or situation (why it happened) and predict possible effects (what might happen as a result). Younger children may have difficulty with causal relationships but can be guided by questions such as "What happened right before this?" and "What usually happens when...?" Older students will need to distinguish between correlation (things that go together, perhaps by chance or because they are both caused by a third factor) and causality (things that make another thing happen). They will also need to understand multiple causes and chains of effects.

Examples:

Arts. After viewing a short dance sequence, each student will describe in writing how it affected him or her emotionally and pinpoint elements in the dance that caused the reaction. The group will then compare their reactions and discuss the differences in how they were affected.

Health/Physical Education. After a discussion highlighting proper care and treatment of the teeth, students will identify what could happen to people who neglect their teeth (they may need dentures) and possible results of denture use.

Vocational Education. Students will construct a timeline illustrating how technology has caused the American standard of living to improve in the last century in four areas: health, transportation, industry, and communication.

Evaluating

This third sub-category of critical thinking involves reorganizing knowledge by judging, or putting a value on, information, arguments, plans of action, etc. Evaluating refers to measuring or judging something against a standard in a systematic way. Evaluating is not the same as expressing a personal attitude; liking or disliking something is not the same as evaluating in the critical thinking sense. Rather, in evaluating, judgments are based on stated or strongly implied criteria. For example, saying "Shakespeare is boring" is expressing a personal attitude or feeling. An evaluation is saying that a Shakespeare play might bore kindergarten children because the language is too difficult and the situations are beyond their understanding.

Evaluating thus involves recognizing, generating, and applying criteria relevant to specific cases. For young children, the first step would be recognizing the difference between purely subjective judgments ("Spinach is yucky!") and supported evaluations ("Chocolate chip cookies would be good at the class party because most people like them"). Next they need experience in making unstated criteria explicit, starting from their own statements. Teachers can ask students the reasons for their judgments ("You say Rambo is

a great movie. What qualities do you think make a movie great?"). At this stage students can also apply predetermined criteria, such as assessing sources of information according to reliability or recognizing specific fallacies. Finally, students should learn how to determine what criteria are appropriate to a particular evaluation and how to apply these criteria, perhaps by developing an evaluation procedure for a project they're working on.

More mature students should consider how criteria themselves may be evaluated, in order to understand how equally good critical thinkers with different frames of reference may evaluate the same thing very differently. At this level, evaluating builds on the skill of identifying assumptions in the analyzing sub-category, because students must, in a sense, enter the minds of other people.

Question stems that may stimulate evaluating include:

* What is the basis of that judgment? Why do you think that?
* How would you rank the options in order of importance? of interest?
* How could we evaluate our class project?
* Are there any logical fallacies in the speech?
* How would you assess the accuracy of that source?

The five evaluating skills with sample objectives follow.

Assessing Information. Students will appraise information and its sources as to reliability (to what extent one can believe it) and relevance (how it is connected to the purpose at hand). Students should learn that printed material is not necessarily accurate and learn some specific criteria to use in judging information, such as publication in a reputable periodical, qualifications and reputation of the author, evidence presented, and corroboration by other sources. They must also learn to decide if material fits their purposes—does it support their argument, is it relevant to the topic of a report, or is it interesting but not really connected?

Examples:

Foreign Language. A high school French class will examine articles written by Americans about the French and assess the reliability of each by looking at the author's qualifications. The teacher will prepare a chart from student discussion on how to judge an author's reliability.

Language Arts. After reading a piece of historical fiction, evaluate it from a historical point of view. Students will note the events and their outcomes in the story. Design a chart to show actual historical events and outcomes and those events as they were portrayed in the story. Students should assess the information for historical accuracy and its relevance to the story's narrative structure.

Determining Criteria. Students will develop a basis for judging assertions, products, works of arts, etc., by establishing criteria or standards and a clearly defined process for applying them. Students should learn that many criteria (e.g., cost, effectiveness, appeal to certain groups, simplicity) can be used in evaluating and that the criteria selected will determine an evaluation's outcome. They should also learn different ways of applying criteria, such as rank ordering, rating scales, quantitative measurement, etc.

Examples:

Arts. After students have prepared one-act plays for production, the class will develop a judging form with specific criteria to be rated and brief descriptions of three levels of performance for each criterion. After judging has been done,

students will discuss the adequacy of their judging form.

Arts. After studying several contemporary painters who seem to be creating a new style, students should develop a rating scale to assess the qualities and strengths of the style. Students may contact an artist to discuss the rating scale in relation to his or her works.

Vocational Education. Develop a list of criteria for selecting the most cost-effective rations for dairy cattle in various stages of growth and production. Apply it to a specific dairying situation.

Prioritizing. Students will order a set of options according to their importance. This can start with something as simple as making a class "to do" list each day and deciding which items are most important to get done. At a more sophisticated level, students must decide how they are defining "important," which involves determining criteria.

Examples:

Health/Physical Education. Students will consider leisure activities available, rank them in descending order of importance, and discuss the rationale for these decisions. Compare and discuss the different priorities of students.

Social Studies. Using an issue such as busing for integration, determine what options for action exist in the situation. After generating a number of options, students should individually rank the options according to at least three criteria. Students should justify their rankings.

Recognizing Fallacies. Students will perceive errors in reasoning, including common logical fallacies such as vagueness, circular reasoning, nonsequiturs, and other propaganda techniques. This is a set of fairly advanced skills closely related to logical thinking in the analyzing sub-category. Students will have to be taught the various commonly recognized fallacies and why they represent incorrect reasoning. They will need considerable practice in identifying these patterns before recognizing fallacies becomes a part of their evaluating techniques. Many language arts, social studies, and math texts contain detailed descriptions of and exercises on the fallacies.

Examples:

Math. After considering that certain tables, charts, graphs, and advertisements might contain incomplete or distorted data, students will examine given statements, rationales attached to charts, etc., for reasoning errors and misleading interpretations.

Vocational Education. After reading about recent consumer protection legislation, choose several products and show how too little information or misinformation can be deceptive (glittering generalities, correlation/causality confusion, etc.).

Verifying. Students will investigate the implications or results of a belief, position, hypothesis, or stance in order to confirm or reject it. Verifying involves what is sometimes referred to as "reality testing," or evaluating an idea or plan against the criterion of feasibility or practicality. In some cases verifying can be done by careful cause/effect thinking; in other cases students can actually try something out and observe the effects.

Examples:

Arts. Students will design and perform dances intended to be funny. They will observe whether the audience responds to the humor. Following the performances, the group will discuss what worked, what didn't, and why.

Math. Students will verify their belief that 4>3>2>1 by arranging Unifix cubes in corresponding groups to represent the amounts in order. Discussion of models

and rationale should ensue.

Science. Students will research the animals on the endangered species list today and a decade ago, and then verify the belief that environmental controls in the U. S. are effective by looking for evidence of direct causal connections between controls and changes in species population. This could include a skill lesson on evaluating evidence.

III. Creative Thinking

The second higher order thinking province in the Integrated Thinking Model is creative thinking. As indicated in the model by the two-way arrow, the boundary between critical and creative thinking is not absolute. Some thinkers even explain all creative thinking in terms of critical thinking or deny the distinction altogether. To many others, however, these types of thinking are different enough in feeling and purpose to make the distinction pedagogically useful. Critical thinking focuses on processing the accepted knowledge to make it meaningful; it reorganizes knowledge by analyzing, connecting, and evaluating it. Creative thinking tends to diverge more from accepted knowledge, using knowledge in either its raw or reorganized form as a springboard for generating new knowledge (new for the thinker or objectively original). This new knowledge, created by synthesizing, imagining, and elaborating with accepted or reorganized knowledge, may range from modifications of an accepted concept to far-reaching, original speculation. In the complex thinking processes, the products of creative thinking will be subjected to the rigors of critical thinking. But at the teaching and learning stage, creative thinking needs a protective, nurturing climate. Thus the teacher is justified in working with the critical and creative thinking skills separately at the initial stages.

Creative thinking uses raw or reorganized knowledge as a springboard for generating new knowledge.

As with critical thinking, creative thinking skills can be grouped into three subcategories. These are listed below and shown in Figure 4.

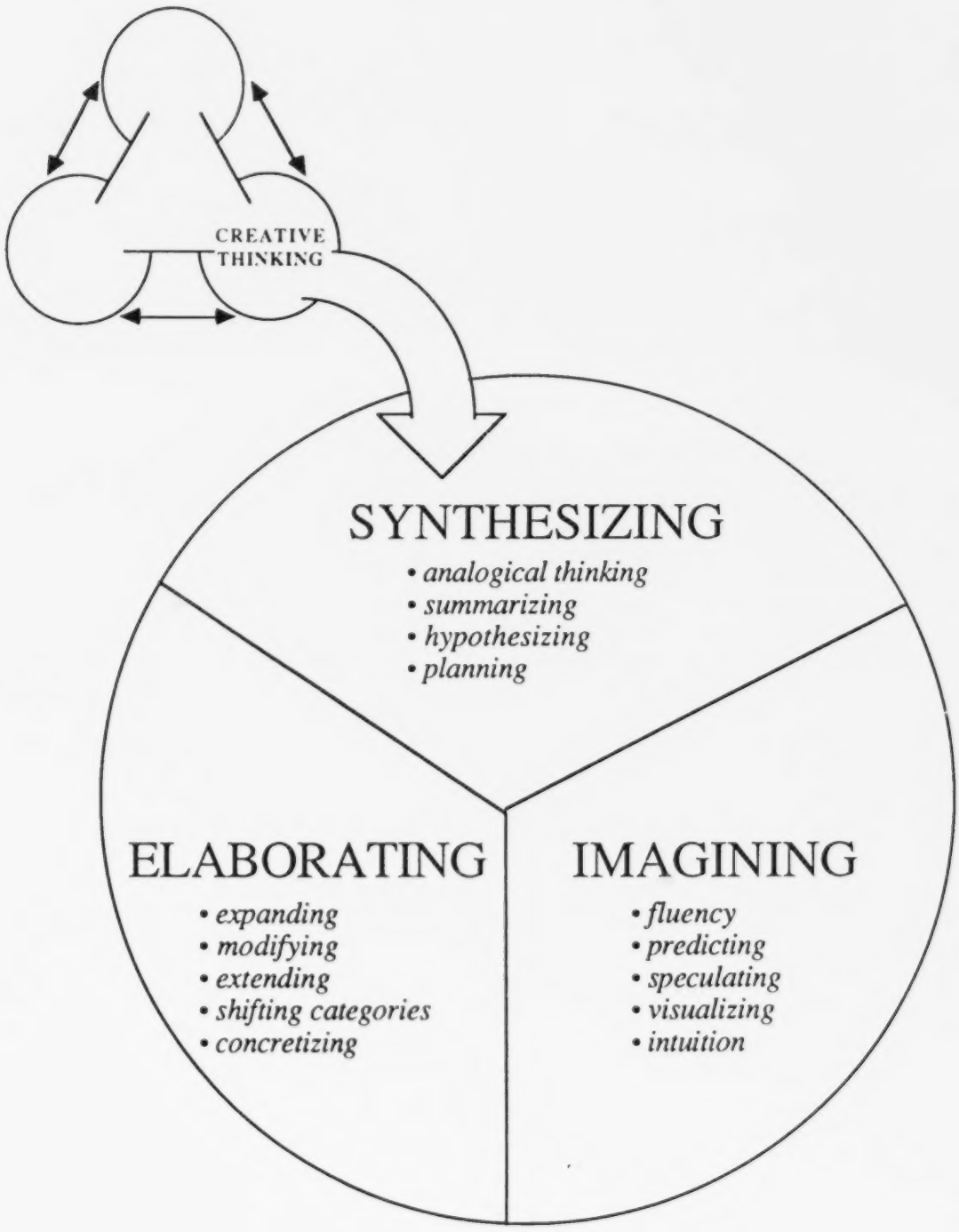
Synthesizing, defined as combining parts to form a new whole. The skills include:
analogical thinking
summarizing
hypothesizing
planning.

Imagining, defined as originating ideas through mental processing. The skills include:
fluency
speculating
predicting
visualizing
intuition.

Elaborating, defined as developing an idea fully. The skills include:
expanding
modifying
extending
shifting categories
concretizing.

Figure 4: CREATIVE THINKING PROVINCE:

Detailed View



Synthesizing

In many ways, synthesizing is the creative thinking counterpart of analyzing, since it involves part/whole relationships, and is the component of creative thinking most like critical thinking. Synthesizing builds on previous analysis in that parts must already have been discovered. But here the focus is on putting parts together to form new wholes rather than finding the parts in wholes. Synthesizing includes combining the most important parts of something to form a summary, comparing and combining attributes (parts) of quite different types of things in analogical thinking, or ordering the parts of a task in planning.

Creative thinking appears in general to be natural for young children. Quite young children express themselves spontaneously in figurative language and do simple forms of planning. Hypothesizing in the formal sense is more advanced, but young children engage in trial and error behavior even if they don't think explicitly in these terms.

Question cues to trigger synthesizing include:

* Can you say that in one sentence?
* What's your plan for doing that?
* Can you come up with an analogy to explain that?
* What hypothesis can you make about the situation? How could you test it?
* Think of a metaphor to express _____ (an abstract idea).

Students can often make abstract or complex ideas clearer or gain insights into their meaning.

The synthesizing skills and sample lesson objectives follow.

Analogical Thinking. Students will be able to use figurative language to express ideas in more vivid and novel ways. By using metaphors, similes, personification and other figures of speech, students can often make abstract or complex ideas clearer and gain insights into their meaning. Statements such as "Fear is a big black dog" followed by specific points of comparison can help students understand a concept in a concrete way and stimulate new ways of looking at the idea. Analogical thinking is different from comparing and contrasting in critical thinking because the things compared are of different types. Comparing involves two laws, or two types of literary genres, etc., whereas analogical thinking compares two seemingly very different types and finds surprising similarities (fear and dogs, life and a football game, etc.). Certain creative thinking programs such as Synectics are based heavily on analogical thinking.

Examples:

Language Arts. The teacher will give examples of metaphors and have students find metaphors in a written selection. Using a series of pictures, students will create metaphors which clarify the meaning of a picture or an object in it.

Social Studies. Brainstorm the various meanings of the word "war." List different kinds of war (between nations or races, bacteriological). List the different qualities of each kind of war and create analogies (metaphors and similes) which define or clarify the meaning of war.

Summarizing. Students will be able to produce a succinct form of a complex body of material. This requires them to identify the main idea and the basic structure and then express these elements more briefly than in the original. They must know what to leave out, which is often difficult for younger students. For many students, it will be necessary for the teacher to model summarizing, both orally and by marking paragraphs to show important and nonessential information.

Examples:

Foreign Language. In fourth-year Spanish, students will write one paragraph in Spanish summarizing stories they have read. They will compare these in small groups to see if they agree on the basic elements needed in the summaries.

Health/Physical Education. After studying sound nutritional practices, students will be able to summarize clearly the important elements in the diet.

Social Studies. After students have read a difficult textbook passage, they will write a precis. Have students compare their precis and discuss reasons for any differences.

Vocational Education. After a field trip to a hospital to learn about medical careers, each student will summarize what he/she has learned.

Hypothesizing. Students will learn to develop a testable explanation for a given situation or set of facts. This skill builds on inductive inferring, in that students must make generalizations about observed data, but in hypothesizing the generalization (hypothesis) must be formulated so that it can be tested by experiment or structured observation (verifying). These skills used together are the basic skeleton of the scientific method, and most science textbooks contain teaching materials to develop them.

Examples:

Science. Collect and examine three soil samples from different areas of the same yard and develop a hypothesis predicting which soil will produce the healthiest plant under controlled conditions. Students should defend their hypotheses.

Social Studies. The students will develop a hypothesis about student opinion which can be tested or verified. For example: More high school girls than boys support the Equal Rights Amendment. Students can devise a survey or questionnaire to test the hypothesis.

Math/Science. Students will predict how much water will be displaced by a given object and express this in quantitative terms (How high will the water level rise if a rock is placed in a graduated cylinder?). Objective verification of actual results will then occur.

Planning. Students will be able to analyze a task and formulate a step-by-step procedure for accomplishing it. This requires deciding what the steps are and finding a reasonable sequence of performing the steps. Useful strategies are for teachers to model planning, and for students to share their plans. Planning may well be a skill related to personality style, with some people preferring detailed written plans and others operating well by planning in their heads.

Examples:

Arts. Before having students work on water color paintings, the teacher will discuss with them considerations in planning their painting, such as value of color, drying time for washes, etc. Each student will write a brief plan before starting the painting.

Vocational Education. To end a unit of study, students will plan a meal including selecting a menu, determining expenses, and developing a preparation schedule.

Arts. Use a planning sheet to develop step-by-step procedures to present a dramatic piece for another class or parents. The planning sheet should include the objectives, steps needed, material needed, and problems anticipated with possible solutions.

These skills used together are the skeleton of the scientific method.

Imagining

Imagining comprises types of thinking that seem most to fit the label "creative" where the goal is moving beyond what is factual and where ideas are less bound by the rules of logic and the measurable. The imagining skills in the Integrated Thinking Model range from predicting probable consequences of an analyzed situation to speculating about more or less remote possibilities to generating ideas through fluency, visualizing, and intuition. Analogical thinking is like imagining in seeking unusual comparisons, often expressing abstract ideas as concrete images. Several of these mental processes can only loosely be called skills, since they are difficult to describe or practice as step-by-step procedures. Despite this lack of concreteness, imagining is very important as a source of new ideas—raw thought to be tested and reorganized by critical thinking or to serve as material for the complex thinking processes.

Imagining is very important as a source of new ideas.

Modeling and other strategies of the holistic approach may be the most helpful ways to foster imagining. With the exception of predicting, which presupposes some facility with inductive inferences, imagining is accessible to young children perhaps even more than to older students or adults who may be uncomfortable with its lack of closure and exactness.

Questions to stimulate imagining include:

* Picture the scene in detail in your head.
* Can you predict what will happen next in the story?
* If _____, what might be all the things that could possibly happen?
* What are all the different ways you can think of to express the number two?

The imagining skills and sample objectives follow.

Fluency. Students will generate many relevant responses when presented with a stimulus. The point of this skill is to produce many ideas so as to have a large body of material to work with. A basic principle underlying strategies to promote fluency is the deferral of judgment—accept all responses at first, encourage many varied and unusual ideas. Evaluating is a different thinking process to be performed separately.

Examples:

Foreign Language. The teacher will drill in vocabulary by asking students to brainstorm vocabulary they know in certain categories, e.g., words for food, nouns starting with R, feminine two syllable words.

Math. When asked to give various ways to represent a number (e.g., 10) students will be able to produce many relevant responses (5 x 2, 1 x 10, 100/10, etc.) Pairs of students could then try to think of five more responses to the same question.

Predicting. Students will judge what things are likely to follow, be caused by, or result from a given situation or set of conditions. To do this, they must analyze the given situation and the future situation, compare these situations or conditions, and infer what may happen in the future because of what's happening now. Because of the critical thinking skills implied in predicting, it is one of the more developmentally advanced creative thinking skills.

Examples:

Science. After studying the catastrophe at Three Mile Island and other nuclear energy disasters, predict the future status of nuclear power plants in the U.S.

Vocational Education. Students will chart changes they think will occur in the relative balance of men and women in the work force because of technological advances in computer science.

Speculating. Students will think and wonder about possibilities. Sometimes referred to as "what if" thinking, speculating may start from contrary-to-fact or whimsical conditions ("What if everyone had the same name?") to stimulate novel ideas and insights that may then be applied to real situations. Unlike predicting, which seeks logically and factually probable ideas, speculating aims at generating interesting, unusual, perhaps humorous ideas. These may or may not lead to hypothesizing and verifying.

Speculating may start from contrary-to-fact or whimsical conditions.

Examples:

Foreign Language. Students will learn about many foreign language-speaking minorities in the U.S. and speculate about possible results of making English the legal national language.

Science. Students will discuss the question, "If this continent had not had such a vast wealth of natural resources, how might our scientific and technological development have been different?"

Social Studies. The nature of family farms has changed dramatically during the past 25 years. Students will speculate on how the family farm will change in the next 25 years.

Visualizing. Students will think in mental images that they can later communicate. Despite the name, these images can reflect any of the sensory system—visual, aural, kinesthetic, tactile, olfactory. Visualizing can be used as a mental rehearsal (as in sports or performing arts), as a preparation for writing or an art activity, as an aid to observation and memory, and as a motivational tool ("visualize what the completed project will look like and how it will feel to be done"). A number of techniques and materials are available to develop visualizing, sometimes found under the names of "guided fantasy" or "visual thinking."

Examples:

Arts. In an elementary music appreciation lesson, have students form visual images as they listen to classical music. These can be shared afterward, leading into a discussion of how composers may be trying to evoke mental pictures.

Arts. Students will listen to an oral reading of prose or poetry eliciting visual images. Students may draw, use color, or use their own writing to represent the visual images experienced during the reading.

Science. During a unit on the circulatory system, the teacher can lead a guided imagery trip through the bloodstream ("Imagine you are a red blood corpuscle," etc.).

Intuition. Though not a skill that can be directly taught, intuition is a valuable mental process that students should recognize and have some notion of how to evoke. Intuition refers to flashes of insight, a seemingly instantaneous understanding without an awareness of sequential, rational thinking, a strong hunch about something without concrete evidence. Intuitions are often based on well-learned knowledge and skills which have sunk beneath the level of consciousness, and thus may be similar to what some refer to as automaticity. Students should see intuition as a type of personal knowledge that can serve

as a starting point for more objective types of knowledge. Intuitions often need to be verified and subjected to other types of critical thinking and may ultimately be rejected, but can also be the spark of truly original ideas.

Examples:

Arts. After studying a number of artists' works, students will be able to intuitively identify painters when shown several very similar paintings they have not seen before.

Health/Physical Education. After playing a game (e.g., volleyball) successfully for a time, a student will have a global, intuitive understanding of the specialized skills, rules, and strategies necessary to play well.

Elaborating

Elaborating means developing an idea, building on and improving it. Elaborating skills can be used to make an idea more useful for a particular purpose or to generate new ideas. As with the other creative thinking skills, the outcome of elaborating is not always clear in advance; sometimes the thinker is "messing around" just to see what may turn up. New ideas and their useful applications may arise more readily from a playful approach than from a strictly goal directed attitude.

Because of this playfulness, the elaborating skills are accessible to students at less advanced developmental levels. Young children like to expand on an idea, change it around (modify), and extend ideas into unusual contexts. Children's literature is full of such elaboration. Shifting categories and concretizing may take more practice for young students, because these skills require thinking in categories and in abstractions.

Question cues for elaborating include:

* Tell me all the details of the event you can think of.
* How could we change the plan to make it less expensive, more fun or easier?
* What are five different types of _____? Give an example of each type.
* Explain democracy in concrete examples. Democracy is _____.

The specific elaborating skills and examples are listed below.

Intuitions may ultimately be rejected, but can also be the spark of truly original ideas.

Expanding. Students will add details, examples, qualifications, etc., to a core concept or principle. This skill builds on fluency and may be used in conjunction with a fluency activity. Expanding ideas helps students understand and communicate them better. This skill is especially important in writing.

Examples:

Foreign Language. Given a general description of a situation, students will write and perform a dialogue.

Language Arts. Students will select a theme or core idea for a short story. As a group, they will use brainstorming or webbing techniques to generate details, descriptions, and examples related to the plot or theme. Students will incorporate the brainstorming ideas into a short story.

Math. Students will expand number sentences into word problems and share them with the group.

Modifying. Students refine or alter a core concept, statement, principle, etc., in order to achieve different purposes. Students will need to be able to compare and contrast the requirements of different purposes so as to modify material appropriately. Revision in the writing process is an example of modifying.

Examples:

Arts. Music composition students will compose several variations on a theme, then discuss the thinking they did in developing their variations.

Vocational Education. A new article of clothing is often developed by a change in size. For example, breeches were magnified into trousers and long stockings shortened into sneaker socks. Students can select existing pieces of attire and either minify of magnify to create a new article of clothing.

Social Studies. Primary students studying the first Thanksgiving can brainstorm changes in the food served between the first Thanksgiving and today. They should try to explain why the Pilgrims did not eat what we do.

Extending. Students will take principles, concepts, and conclusions from one context or frame of reference and apply them to another. This skill is similar to analogical thinking in that elements from different universes are combined. Making connections and seeing relationships between disparate areas often yield new, productive ideas.

Examples:

Health/Physical Education. Students will consider concepts of teamwork in sports situations and relate this knowledge to cooperative problem solving situations in classroom settings (e.g., science).

Math. Students will think of ways to apply the mathematical equations format to other curriculum areas, such as science and social studies. For example: seeds + sun + water + soil = healthy plants.

Social Studies. After determining the major causes of the Civil War, students will extend their conclusions about the causes of civil unrest to another context (period of civil unrest). Students can decide whether the causes of one war can be extrapolated to another one.

Shifting Categories. Students will be able to change the direction of their thinking and take alternate points of view. This flexible thinking is very important in generating new ideas and in the complex thinking processes. It is often linked with fluency in creativity theory and materials, and can be developed by asking students to think of items from many categories. It builds on the critical thinking skill of classifying, in that a familiarity with categories is implied.

Examples:

Health/Physical Education. In a role-playing situation, the students will take various points of view regarding the implications of using alcohol. Debriefing of the activity will include sharing thoughts and feelings.

Language Arts. Generate a list of the many varied items Huck Finn needed for his ride down the Mississippi River on a raft. After generating an extensive list, divide the class into small groups. Students will define categories and place each word into a category. Groups will name their categories and tell why the category was chosen.

Concretizing. Students will be able to make a general idea specific by giving examples and applications which will make an abstraction meaningful. This skill builds on the critical thinking skill of finding the main idea and requires understanding hierarchical relationships, so it is somewhat more developmentally advanced than the other elaborating skills. Like the other elaborating skills, it enhances both the students' own understanding and their ability to communicate that understanding.

Examples:

Foreign Language. After learning a certain grammatical rule, students will write a paragraph in which each sentence exemplifies the rule.

Math. Students will create their own models of the tenths and hundredths decimals from paper, straws, Unifix or Multi-link cubes. Students will orally compare their models and discuss the names of the modeled numbers.

Science. Students will produce a science fiction skit incorporating knowledge learned in an astronomy unit.

IV. Complex Thinking Processes

Complex thinking produces an integration of accepted, reorganized, and generated knowledge.

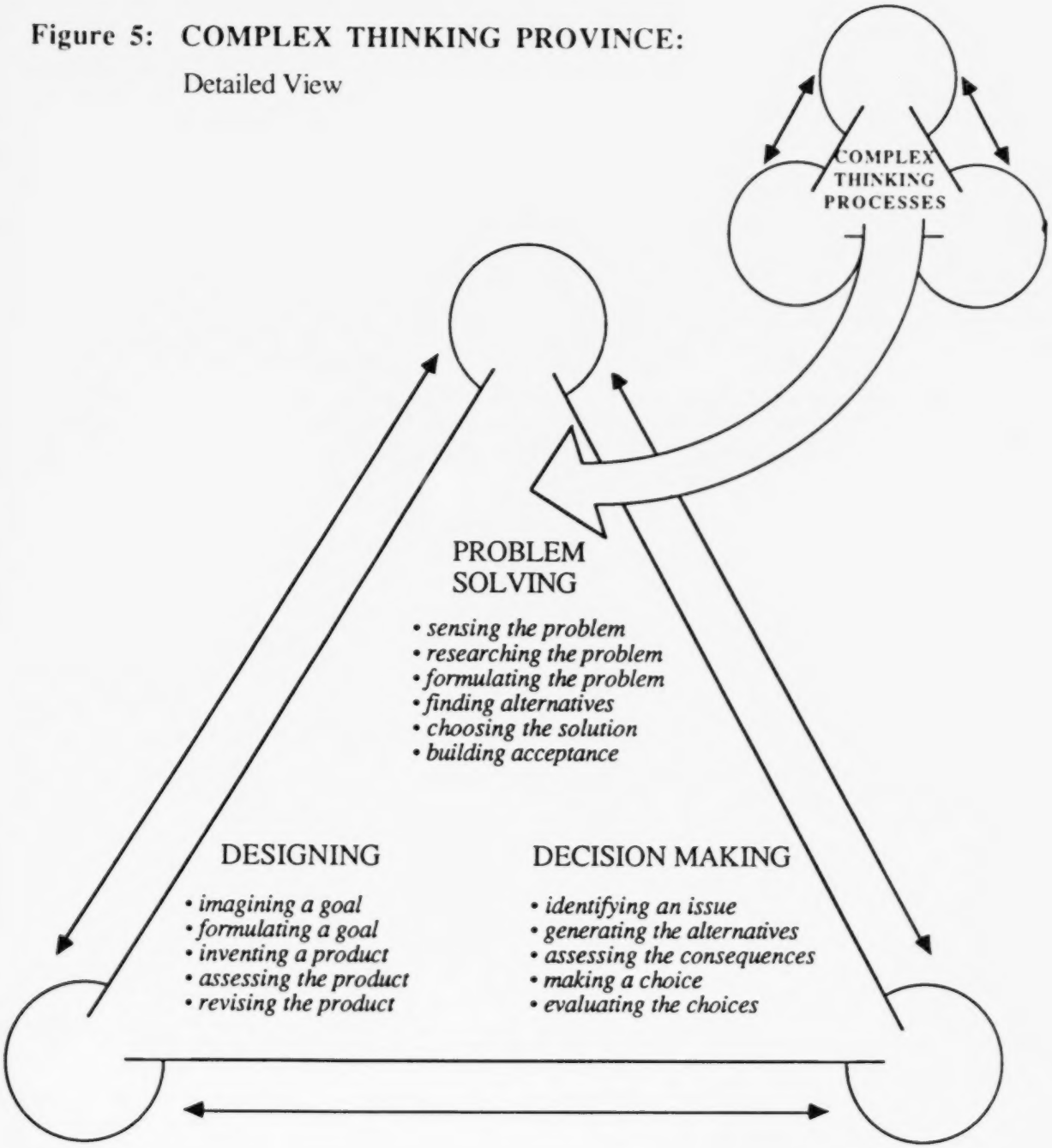
At the center of the Integrated Thinking Model are the complex thinking processes which combine the skills and knowledge types of the other three provinces of thinking—content/basic, critical, and creative. Complex thinking produces a goal-directed integration of accepted, reorganized, and generated knowledge (see Figure 5). These thinking processes are most often directed at the world of action. That is, problem solving seeks a solution to be put into effect; designing creates a work of art to be composed or an invention to be built; decision making arrives at a decision to be carried out.

The complex thinking processes incorporate critical and creative thinking skills in various ways and with various degrees of sophistication. Thinkers also vary in how much they consciously analyze thinking processes into discrete skills. Teachers must consider the individual differences when deciding how analytical they should be in teaching complex thinking. Sometimes teachers will need to teach a step-by-step process of complex thinking; other times they will use the holistic approach to encourage students to think complexly.

Listed here are outlines of three complex thinking processes—problem solving, designing, and decision making. Each is described as a set of steps, with the critical and creative thinking skills typically used in each step. These generic outlines are not prescriptive formulas to be applied automatically in all contexts, since different academic disciplines have developed processes specific to their needs, and thinkers will also need to adapt the process to a given task. These generic models illustrate the steps common to most instances of the thinking processes. The purpose of presenting such models is to emphasize the commonalities of thinking that exist across disciplines. Generic models also give educators and students a common vocabulary, which emphasizes that thinking is fundamentally similar throughout the disciplines and in everyday life.

Figure 5: COMPLEX THINKING PROVINCE:

Detailed View



Problem Solving

This complex thinking process may be defined as using systematic methods to clarify and reach a goal. It is used with non-routine problems, those that have no obvious formula or recipe. Such problems can be found in the academic, aesthetic, personal, social, or public policy domains. Students need many problem-solving and problem-posing experiences throughout their education, starting with simple problems directly related to their own experience in the younger years and progressing through complex problems enmeshed in the various academic disciplines at the high school level. Solutions reached should not overshadow an understanding of the process by which they are reached. Group discussions of how different students have attacked problems are helpful in achieving this understanding.

The main steps in the problem-solving process are consistently present, but the critical and creative thinking skills vary with the problems.

Sensing the Problem: intuition, visualizing, fluency, identifying assumptions

Researching the Problem: assessing information, shifting categories, classifying, recognizing fallacies

Formulating the Problem: summarizing, inferring, hypothesizing, concretizing, identifying main ideas

Finding Alternatives: expanding, extending, modifying, predicting, fluency, speculating

Choosing the Solution: assessing information, comparing/contrasting, determining criteria, prioritizing, verifying

Building Acceptance: planning, fluency, shifting categories, inferring, identifying causal relationships, predicting

The following example of a problem-solving activity shows how the critical and creative thinking skills interact in this complex thinking process. Then brief examples from different subject areas are listed.

Problem Solving: An Extended Example

A multidisciplinary unit at the senior high level which could be used in a health or social studies course

Topic: Considering solutions to the problem of a predicted rapid increase in the birth of babies with Acquired Immune Deficiency Syndrome.

Background: During a newscast on All Things Considered, May 26, 1987, a health official predicted that by the year 1991 we would have 10,000 babies born with AIDS in the United States. The class has studied basic background information about the disease (in health) or the social implications of the epidemic (in social studies).

Sensing the Problem: The class is presented with the prediction above. They then may be asked to think about all the implications of this prediction coming true. This may be done by brainstorming a list individually or in a group using fluency, visualizing the experience of being a relative or caretaker of a person with AIDS, or imagining life as a young person with AIDS. They may also be asked to identify the assumptions of the predictions, such as the birth rate, the infection rate, the influence of educational material on potential parents, and so forth.

Researching the Problem: Now that the students are sensitized to the problem, they will need to collect more information by library research and interviewing health officials, social workers, and possibly people with AIDS. In doing this research, they will be involved in recognizing fallacies, assessing information from various sources, and classifying problems or sources of information.

Formulating the Problem: At this point in the problem-solving process, the students (or individual students) need to take the information they have generated and crystallize it into a form amenable to solution. This involves summarizing and inferring about the information, determining the main idea or underlying problem in the situation, and concretizing this underlying problem in specific terms. For instance, the problem might be stated as "How might we provide care for babies born with AIDS without endangering society?"

Finding Alternatives: Now the students again need to use fluency to generate a variety of possible solutions to the problem as stated. This may involve predicting based on the researched information, speculating beyond what they have researched, expanding or modifying a simple idea, or extending ideas from one frame of reference into the specific AIDS situation. For example, the notion of hospice care for the elderly might be modified to the care of AIDS infants.

Choosing the Solutions: This step has two parts: determining criteria and applying those criteria to alternative solutions. Determining criteria, or deciding what qualities will be used to judge the solutions against, involves assessing information. For instance, students might want the solution to protect society, give humane treatment to the people with AIDS, be economically feasible, and be acceptable to a majority of society. In applying these criteria, students will be prioritizing and comparing the alternatives and verifying what the results of an alternative might be.

Building Acceptance: The final stage involves considering how to accomplish and gain acceptance for a solution. (In a different type of problem, such as how to raise funds for band uniforms, students may actually have to build community acceptance for their solution.) To build acceptance for a solution, students must plan the steps necessary to carry out the solution, predict what may happen at various points of this plan, and identify causal relationships (i.e., why people might react in certain ways).

Brief examples of problem solving:

Arts. Solve the problem of raising money for a band trip.

Foreign Language. Solve the problem of finding a native speaker to converse with.

Health/Physical Education. Solve the problem of following a healthful, nutritious diet in a world of junk food.

Language Arts. Solve the problem of the fear of public speaking which handicaps so many people.

Math. Solve the problem of figuring out how to attack non-routine math problems.

Science. Solve the problem of the breakdown of the ozone layer.

Social Studies. Solve the problem of assimilating immigrants into our community.

Vocational Education. Solve the problem of finding a suitable job based on training and experience.

Designing

This complex thinking process may be defined as inventing products and information in some form. These products can be works of art (paintings, musical compositions, dance sequences), mechanical or technical inventions, social or cultural events, computer programs—any type of concrete creation planned to fit some goal or purpose. As with problem solving, very young children are capable of designing in a global, intuitive way, though they may find it difficult to describe their process or purpose. More complex designing requires more explicit analysis and planning, particularly when the product is to be produced by more than a single individual. Business, the arts, and engineering all have sophisticated design techniques specific to their disciplines that make up a significant part of professional training. The challenge to K-12 educators is to teach students some of these complex designing processes without shaking their confidence in their existing designing abilities. Too often formal training in writing or visual art, for example, only convinces children, who may have written or drawn delightful compositions, that they can't write or draw.

Designing is inventing any type of concrete creation to fit some goal or purpose.

The generic outline of the designing process follows. As with the problem-solving outline, the main steps are present but the specific skills change. Following the outline are extended and brief designing examples.

Imagining a Goal: fluency, shifting categories, speculation, visualizing, intuition
Formulating a Goal: visualizing, predicting, identifying causal relationships, recognizing patterns, hypothesizing, planning, logical reasoning
Inventing a Product: fluency, planning, expanding, concretizing, shifting categories, analogical thinking, visualizing
Assessing the Product: determining criteria, assessing information, comparing/contrasting, recognizing fallacies, verifying
Revising the Product: expanding, extending, modifying

Designing: An Extended Example

An early primary unit used to introduce students to the designing process by means of planning (designing) a real class activity

Topic: Designing an activity or event to enable students to share with their parents the literature they have been studying.

Background: A second grade class has been studying literary forms through their reading program and by writing poems, stories, and reports. The teacher would like to end the unit by sharing with the parents what the students have learned and produced. The students have not had formal (direct) instruction in the designing process, but they have done informal planning. They have been taught fluency, visualizing, and planning as specific thinking skills.

Imagining a Goal: The teacher can tell the class his or her goal of having them share what they have been doing in their literature study with their parents and ask them to individually visualize a way the class might do this, including how they and their parents might feel about this sharing experience. Next, students can report what they visualized to the rest of the class, and the teacher can guide them to notice how many different ideas they have. These can be listed—perhaps booklets, a newspaper, a taped or videotaped poetry reading to be available at open house, a party with writing displayed, a performance of choral

and individual readings, etc.—and classified, in this case as publication and performances. At this point the teacher tells the students that they have been using the skill of shifting categories and has them practice by adding more items to their groups and challenging them to think of additional categories. (If this is their first experience with shifting categories as an explicit skill, the teacher will want to practice the skill in other subjects.)

Formulating a Goal: The teacher explains to the students that they need to choose one sharing activity from their many good ideas, emphasizing that they may combine several ideas. As they discuss possibilities, they will be predicting how various ideas will work and trying to think about what effects a choice might have and what they would need to do to bring it about (identifying causal relationships). They may also be using logical reasoning as they argue for a choice. When the group has reached consensus, the teacher can point out the process they've used of moving from imagining to formulating a goal, perhaps referring to a wall chart of the designing process. (Terminology may need to be simplified for young students just learning the process, but the main steps should be as consistent as possible through the grade levels to facilitate transfer and continuity.)

Inventing a Product: At this point the process will vary somewhat depending on what activity (product) the class has chosen. If they have decided to have an assembly for their parents, they will first expand and concretize this core idea by thinking about what they will do at the assembly in specific detail. They may use analogical thinking by comparing the assembly to a present for their parents. They will next use planning, making a list of what they need to do to get ready and a timeline. Throughout this step the group will be using fluency and shifting categories as they generate ideas. When the group has completed this step the teacher will again relate their experience to the design process, but with students this age, the teacher would probably not name all the discrete skills they used. Since planning, fluency, and shifting categories have been explicitly taught, they should be pointed out, but labeling the other skills might better be reserved for higher grade levels.

Assessing the Product: For this project, this step can be combined with the next step, Revising the Product. After the assembly has occurred, the group should evaluate its success. How well did it help them share what they had learned? Did it turn out as planned? Were the positive feelings they had visualized in the first step created? In this discussion they will be comparing/contrasting, verifying, and assessing information. As they evaluate, they can ask how it might be improved or changed if they were to do it again (modifying, extending). The teacher can label this evaluation process as assessing and revising the product and lead the class to review the entire design process. To reinforce their understanding of the process, another design activity could be one with the same class later in the year, perhaps this time designing a product instead of an event.

Brief examples of designing:

Arts. Compose a piece of music for a specific occasion.

Foreign Language. Design a foreign language folk festival to encourage interest in the study of foreign languages.

Health/Physical Education. Design a personal fitness plan.

Language Arts. Compose a piece of original writing.

Math. Design a computer program to solve a certain type of math problem.

Science. Design an invention to share at the inventors' fair.

Social Studies. Design a constitution for your school building.

Vocational Education. Design an attractive cafeteria set up using nutritious foods.

Decision Making

This complex thinking process may be defined as choosing from alternatives systematically. As with the other complex thinking processes, students are able to make decisions from an early age, but generally not in a consciously rational way. The goal of instruction in decision making is to help students learn a sequential, objective alternative to the natural "gut feeling" style, and to make them aware of the advantages and disadvantages of different decision making techniques. They also need to be aware of the different emphases on objective and subjective decision making among various academic and practical domains. An art critic makes decisions about the merits of a painting differently from a home economist determining the best buy in floor waxes.

Below is the generic outline for decision making, again combining constant main steps and varying specific skills. After the outline are an extended example of decision making and several brief examples.

Identifying an Issue: identifying the main idea, recognizing patterns, identifying assumptions, recognizing fallacies

Generating the Alternatives: fluency, extending, shifting categories, hypothesizing, speculating, visualizing

Assessing the Consequences: classifying, comparing/contrasting, determining criteria, identifying causal relationships, predicting, analogical thinking

Making a Choice: summarizing, logical thinking, inferring, concretizing, intuition

Evaluating the Choices: assessing information, verifying, intuition

The goal of decision making is to help students learn an alternative to the 'gut feeling' style.

Decision Making: An Extended Example

A middle school social studies activity applying decision making within an election unit

Topic: Examining the thinking process involved in deciding which presidential candidate to support.

Background: Holding a mock election during the U.S. presidential election period is a common activity in secondary government classes, involving students campaigning for their candidates, giving speeches, and holding a school election. This unit focuses on the thinking involved before such activities and aims at giving students a rational process for deciding which candidate they support. Although this will not be the students' first exposure to decision making, the process itself will need to be reviewed and emphasized, since young students rarely think through their decisions about supporting candidates.

Identifying an Issue: With this topic, the issue is already identified. In another decision-making lesson, such as deciding whether the electoral college system should be abolished, students may need to clarify exactly what the issue is.

Identifying the Alternatives: This step involves researching who the candidates are. Depending on when in the election process the activity occurs, this may be a simple task of identifying each party's candidate, or it may involve determining who are declared candidates for party nomination and who are probable, but undeclared, candidates. This might require some hypothesizing or speculating (e.g., if Gary Hart drops out of the race, will Mario Cuomo enter?) and assessing information as the students read political analysis in the newspapers. They may also classify candidates according to political party, stands on the issues, leadership style, and personal character.

Assessing the Consequences: This stage is the heart of rational decision making.

Each student must determine what criteria he or she believes are most important in judging a potential candidate. This step could be done by first having the group brainstorm possible criteria. The class might generate such criteria as "good speaker," "believes in strong national defense," "in favor of nuclear test ban," "good family values," "from the Midwest," etc. Next the group should classify their criteria into meaningful categories, decide whether their categories cover all important types of criteria, and add to their categories and criteria if necessary. A reasonable list of categories would include positions on issues (with specific issues listed), personal character and leadership ability, experience, regional and ethnic background, and political affiliations. Middle school students may need to discuss why these criteria are relevant. Such a discussion would involve predicting how a person of a given regional background might act as president, identifying causal relationships between leadership ability and passing legislation, comparing and contrasting the results of various positions on an issue, etc. The next step would be for each student to decide which criteria are most important to him or her. This requires students to think about their own political beliefs about the presidency and the issues. Each student must then rate each candidate according to the selected criteria. Some instruction in ways to chart this evaluation may be necessary. Students should then share the weights they've given to the criteria so they realize that different choices may be equally reasonable, but based on different values (i.e., different weightings given to criteria).

Making a Choice: Each student must now summarize the ratings of the various candidates and choose one to support. This will involve inferring from all the evidence how a candidate would perform as president, using logical thinking to determine the relative advantages and disadvantages of all the candidates and thus narrow the field, and considering "gut feelings" about candidates (intuition).

Evaluating the Choice: Students may evaluate their choices to a limited extent by debating with their classmates about the reasons for their choices. The main evaluation will come by watching the progress of the campaign (did they accurately rate their candidate's personal character?), and how the candidate fares in the election or in office. Before that time, however, students could develop questions to use later to assess information and verify or test their choice. That is, what will indicate that their candidate is performing as predicted? How do you decide if a president is successful? Might you change your criteria when you see the actual outcomes?

Adding this emphasis on the thinking process of decision making in a presidential campaign should help students improve their thinking abilities as well as learn the mechanics of the election process.

Brief examples of decision making:

Arts. Decide whether old movies should be colorized.

Foreign Language. Decide which foreign language poem to use for story telling.

Health/Physical Education. Decide which sports to participate in this school year.

Language Arts. Decide an issue raised in a literary work. Compare your decision with the author's.

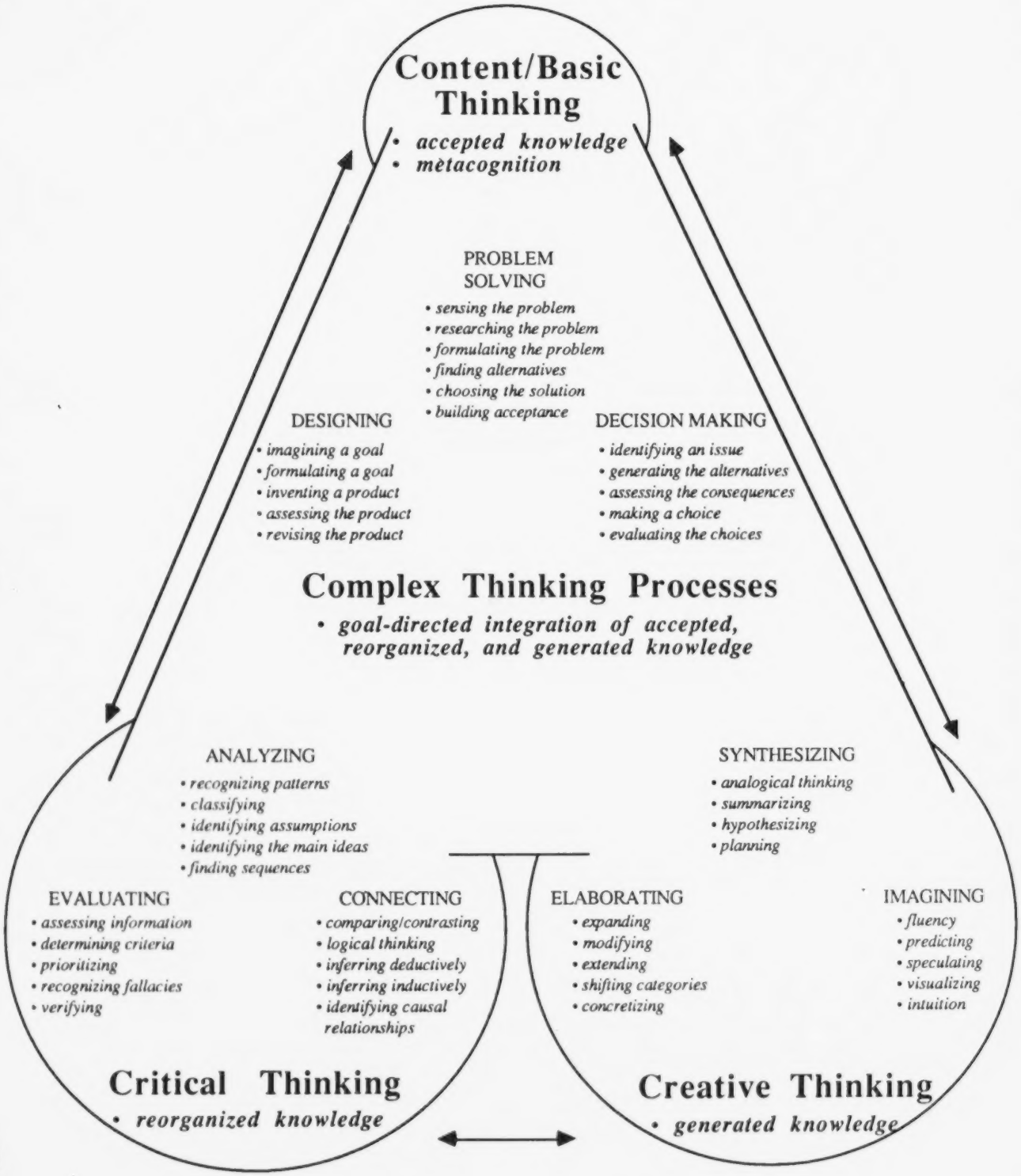
Math. Decide how much calculator use is helpful to the development of your math skills.

Science. Decide whether the manned space program should continue.

Social Studies. Decide which school districts should be consolidated.

Vocational Education. Decide whether farmers should be allowed unlimited use of chemicals on their land.

Figure 6: INTEGRATED THINKING MODEL:
Complete Model



Analyzing and Evaluating the Curriculum

If schools are to determine whether their curriculum adequately addresses the goal of teaching thinking, they need a conception of what the components of thinking are and what instructional strategies are appropriate.

In addition, they need:

—a model of what an effective, coordinated schoolwide plan for teaching thinking should include. (What should a plan look like?)

—a suggested procedure for developing such a plan. (How do we create such a plan?)

—suggested procedures, including sample instruments, for assessing the current curriculum by comparing it to the model plan. (How do we compare our current curriculum to such a plan?)

Essentials of a Model Schoolwide Plan for Teaching Thinking

Although different authorities advocate different approaches, most would agree on certain essentials, including:

—**Agreement among the staff about definitions of thinking and about what thinking skills and processes should be learned by students.** Reaching consensus requires study and discussion, especially with teachers from different disciplines, but is important in providing consistency and reinforcement in teaching. It is helpful to take a long-term, outcomes-based view—what thinking abilities do we want graduates of our system to have?

—**Use of a common thinking terminology across disciplines and grade levels.** This follows from the preceding essential. If the same or similar skills are labeled by the same name in many contexts, students will find it easier to remember them and to grasp their essential qualities even when superficial differences exist in the way skills operate in different contexts. Also, teachers will find it easier to collaborate and communicate if they use the same language.

—**Focus on a limited number of skills taught thoroughly rather than many taught haphazardly.** As with any skills learning, students need considerable practice, review, and reinforcement to achieve mastery. Perhaps one reason that many students fail to become proficient thinkers is that thinking is often taught incidentally without planned review and practice. Even if teachers choose to use the holistic approach—presenting students with assignments that challenge them to think without teaching them explicit skills—the teachers should themselves understand what types of thinking are being exercised in such assignments and plan several holistic lessons that require the same type of thinking.

—**Agreement about when various skills are to be taught and reinforced.** This agreement will also require much discussion among teachers, but is the only way to ensure that all the agreed-on skills and types of thinking are taught and developed sufficiently, yet without duplication, throughout the students' school careers. As above, schools not teaching thinking as explicit skills should still have a general sense of scope and sequence.

—**Emphasis on affective as well as cognitive aspects of thinking.** How students and teachers feel about themselves as thinkers and how they feel about the things they're thinking about has great impact on how well they think. The general strategies of the holistic approach (open, encouraging classroom climate; thoughtful questioning style; etc.) are important in helping students develop self confidence in themselves as thinkers.

Process for Developing a Schoolwide Plan

The process for developing a schoolwide plan for teaching thinking is similar to that used in planning any school curriculum.

The process schools might use as they develop a schoolwide plan for teaching thinking is similar to that used in planning any school curriculum or program, embracing decisions about rationale, goals, activities, timeline, etc. Carolee Matsumoto presents in Figure 7 a list of questions to consider about teaching thinking.

Allan Glatthorn (1987 pp. 76-84) describes a method of developing a schoolwide plan for teaching thinking by infusing thinking instruction into the curriculum. He suggests the following steps.

Step 1. A thinking skills committee develops its own list of higher order thinking skills and processes for students. (This presupposes that they have studied some of the literature on thinking. The committee might adapt or choose from the skills of the Integrated Thinking Model, for example.)

Step 2. Decide where in the grade levels and academic disciplines the various skills and processes can be incorporated. Each skill and process should be taught in several subject areas to ensure transfer, and students should also be encouraged to apply skills to their personal life. For instance, if classifying is a chosen primary grade skill, students should classify books in reading, leaves in science, types of work in social studies, and perhaps hobbies in their personal lives. The location of a particular skill depends on its developmental level, the thinking demands of the content, and the need for timely reinforcement of the various skills throughout the K-12 span.

Step 3. Identify existing units and develop new units within the subject area which develop the selected thinking skills. Units should include both lessons focusing on teaching the skill or process (explicit skills instruction) and lessons that use the skills to teach content (holistic approach).

Figure 7: QUESTIONS SYSTEM PLANNERS NEED TO ASK

Carolee S. Matsumoto

The following are questions that system planners need to consider when incorporating higher-level thinking into teaching and learning.

Input

Development of a rationale:

1. Why should we be concerned with higher-level thinking?
2. Do we have a commitment to intelligent behavior?
3. Do school administrators and committees (boards) support, model, and promote higher-level thinking and intelligent behavior?

Input of outside data and information from research and practice:

1. What do the experts say about this (Costa, Paul, Perkins, Sternberg, and others)?
2. What are the various approaches that have been taken?
   a. Formal programs (Project Intelligence, Instrumental Enrichment, Philosophy for Children, and others).
   b. What outstanding school systems, state programs, and other plans exist?

Action

Definition, setting goals, and internal reflection:

1. What do we mean by higher-level thinking, cognitive development, and intelligence?
2. What elements/areas of thinking are we going to include as goals for the K-12 learning experience?
3. What are we already doing to promote thinking?
   a. What institutional structures and practices promote thinking?
   b. Does/will/how can the school culture support change to incorporate a priority to promote higher-level thinking?
   c. What teacher behaviors encourage thinking?
   d. What curriculums/programs expect, stimulate, or provide opportunities or contexts for higher-level thinking?
4. What do we do that inhibits or restricts thinking?
   a. What institutional structures and practices inhibit thinking?
   b. What teacher behaviors inhibit thinking?
   c. What curriculums/programs inhibit or restrict thinking?
5. How can and will we use computers/technologies to help us develop thinking?
6. What are our immediate goals and priorities?

Procedures

Action:

1. How can we create expectations that demand higher-level thinking and cognitive development?
2. What are the training/development implications for:
   a. Administrators?
   b. Teachers?
   c. Schools and systems?
   d. Teacher training in universities?
3. How can we develop K-12 curriculums that expect, stimulate, or provide opportunities or contexts for higher-level thinking and cognitive development?
4. How can we infuse higher-level thinking and cognitive development efforts, and how will they do so?
5. Who will support these expectations, training, and curriculum development efforts, and how will they do so?
6. Can our supervisors (principals, department chairs, or other administrators) cognitively coach, supervise, and evaluate?
7. How will the answers to all of these questions be conceptualized and realized in our schools and systems?
   a. What steps will we take?
   b. What additional support (human and financial) is necessary?
   c. How will we maintain a long-term commitment?
8. How can we continually inform, educate, and train parents and community members to understand and support their children's and our efforts?

Practice

Evaluation:

1. How will we know if students have developed their thinking skills, strategies, and self-confidence?
2. What evidence/indicators will reflect staff (administrators and teachers) skills in thinking?
3. How will we access supervisors' (principals, department heads, and others) ability to coach cognitively?
4. What processes will continually develop and revise curriculums for the infusion of thinking and cognitive development?

Institute

School culture:

1. How will we know that thinking and cognitive development are a part of the school culture?
2. How can we be sure that everyone in the school system is committed, participating, and prioritizing this endeavor?

(Costa, 1985. *Developing Minds*, p. 328-9)

Step 4. These units can then be cross-referenced for grade level and subject area, giving a master list of where the various skills and processes are taught. This list should be evaluated for appropriate grade level placement, reinforcement without undue duplication, and integration of thinking and content.

The grid, "Incorporating Higher Order Thinking in the Curricular Areas," in Appendix A can be used for developing such a plan and also for analyzing curriculum now in place. It serves as an easy way to consolidate decisions about where the various thinking skills and processes should be taught or information about where they currently exist.

Evaluating the Curriculum for Thinking

With the above model of what a good thinking curriculum might be and a plan for developing it, a school committee can evaluate current district curriculum. In practice a district will probably not completely separate analyzing the current practices from developing their desired schoolwide plan for teaching thinking. When planning committee members decide on their common list of skills and processes (step 1), where these should be taught and expanded (step 2), and identify and develop teaching units (step 3), they will be examining and assessing their existing curriculum and instruction. And the desired thinking plan will include in its scope and sequence some units and instructional practices already in place and some that need to be added as new material or modifications of existing curriculum.

All too often, what is actually taught in classrooms bears only a slight resemblance to the written curriculum.

So what should a district do to determine the extent to which their existing curriculum (all school programs) matches their desired schoolwide plan for teaching thinking? Glatthorn makes a useful distinction between different entities referred to by the word "curriculum." The written curriculum consists of a district's curriculum guides, course guides, scope and sequence charts. The taught curriculum is what is actually taught by the teacher. The learned curriculum is what the student actually learns. Although the learned curriculum is the most important, measuring student learning is best done after a program has been in effect several years. But by evaluating the written and the taught curricula, a committee will uncover some indicators of what students are learning.

Evaluating the Written Curriculum. Curriculum and course guides can be analyzed by using the grid, "Scope and Sequence within a Discipline or Grade Level," in Appendix B. The guides can be examined for inclusion of various thinking skills and processes, and for suggested activities that would imply the use of certain skills. Especially for schoolwide plans that strongly emphasize the holistic approach, it is important to examine content objectives and activities to determine what types of thinking they demand of students. Because of the open-ended nature of many holistic approach assignments, determining what type of thinking an activity elicits is more elusive, since students respond in different ways to an activity. An instrument such as Barry Beyer's "A Thinking Skills Checklist" (see Appendix C) can also guide analysis of the written curriculum. Comparing current curriculum guides with a model plan will suggest how a school could revise or expand its thinking instruction options.

Evaluating the Taught Curriculum. All too often what is actually taught in classrooms bears only slight resemblance to the written curriculum of a district. To find what the actual thinking curriculum of a school is, therefore, the taught curriculum must be evaluated along with the written curriculum. This taught curriculum includes both the teacher's cognitive objectives and activities and the general instructional strategies dis-

cussed earlier, such as climate, questioning style, and modeling thinking behavior. Again, this evaluation is especially important when a school has chosen the holistic approach, since so much of the instruction shows up only as teacher behavior and teacher/student interactions.

This taught curriculum can be analyzed by classroom observations, talking to teachers and students, and examining teacher assignments and tests. Logs or teaching journals kept by teachers or detailed lesson plans could also provide evidence when available. The ASCD videotaped training materials, Another Set of Eyes: Techniques for Classroom Observation, could help teacher supervisors and others learn a variety of objective observation techniques. Several instruments in the Appendices may be used for structuring these observations and evidence gathering: "Classroom Observation Checklist" (Appendix D), "Self Reflection on Your Teaching" (Appendix E), "How Thoughtful Are Your Classrooms?" (Appendix F), "Classroom Observation Form" (Appendix F), and parts 2 and 4 of "A Thinking Skills Checklist" (Appendix C). Since several of these instruments look at student behavior, they provide some information about the current level of student thinking.

Conclusion

After the school thinking committee has completed this evaluation of the current curriculum in comparison with their desired schoolwide plan for teaching thinking, they must decide what actions to take and set a timeline for accomplishing them. Action might include staff development activities, curriculum modification and writing, and additional study of thinking literature.

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Sternberg, Robert. *Intelligence, Information Processing, and Analogical Reasoning: The Componential Analysis of Human Abilities.* Hillsdale, NJ: Erlbaum, 1977. This is a description of Sternberg's componential theory of intelligence.

Sternberg, Robert. "Teaching Critical Thinking Part 2: Possible Solutions." *Phi Delta Kappan,* Vol. 67, December 1985, pp. 277-280. This article addresses ways to teach critical thinking in order to prepare students for problems of everyday life. Sternberg introduces the program "Intelligence Applied," a year-long course divided into five parts. To ensure the transference of teaching for thinking, students must solve problems as they occur in the real world.

Sternberg, Robert, and D. K. Detterman, eds. *Human Intelligence: Perspectives on Its Theory and Measurement.* Norwood, NJ: Ablex, 1979. Information processing approaches to intelligence and intelligence testing are the subjects of this collection of papers.

Sternberg, Robert, and Bhanan Kastoor. "Synthesis of Research on the Effectiveness of Intellectual Skills Programs: Snake Oil Remedies or Miracle Cures?" *Educational Leadership,* Vol. 44, October 1986, pp. 60-67. Thinking skills programs including Instrumental Enrichment, Philosophy for Children, SOI, Problem Solving and Comprehension, and Odyssey are considered. Success in these programs developing thinking skills depends on many implementation-specific variables.

Sternberg, Robert, ed. *Human Abilities: An Information Processing Approach.* New York: Freeman, 1984. The information processing approach to human abilities is introduced.

Stiggens, Richard, Evelyn Rubel, and Edys Quellmalz. *Measuring Thinking Skills in the Classroom.* Washington, DC: National Education Association, 1986. An assessment planning framework has been developed to measure basic thinking skills. An assessment of five fundamental cognitive operations (recall, analysis, comparison, inference, and evaluation) is demonstrated.

Sylvester, Robert. "A Child's Brain." *Instructor,* September-December, 1982. In a three-part series, the author presents new discoveries in brain research including the cyclic nature of brain development and how the brain is organized for action.

Sylvester, Robert, Jeanne Chall, Merlin Wittrock, and Leslie Hart. "Educational Implications of Recent Brain Research." *Educational Leadership,* Vol. 39, October, 1981, pp. 6-17. This article presents new knowledge about the functioning of the human brain which may enable schools to teach thinking effectively.

Taba, Hilda. "Implementing Thinking as an Objective in Social Studies." In *Teacher's Handbook for Elementary Social Studies.* Reading, MA: Addison Wesley, 1967. A landmark handbook for educators, this work provides a good foundation for curriculum development.

Torrance, E. P. *Creativity: Its Educational Implications.* Dubuque, IA: Kendall/Hunt, 1967. Creative thinking makes a difference in the creative development of students.

Torrance, E. P. *The Search for Satori and Creativity.* Buffalo, NY: Creative Education Foundation, 1979. This is an excellent interpretation of creativity, the process of creating, and the "a ha" inherent in the creative process.

Von Oech, Roger. *A Whack on the Side of the Head: How to Unlock Your Mind for Innovation.*

New York: Warner Books, 1983. Von Oech provides a guide to creative strategies to promote creative thinking and unlock the mind for innovation.

Vye, Nancy, and John Bransford. "Programs for Teaching Thinking." ***Educational Leadership,*** **Vol. 39, October, 1981, pp. 26-28.** The authors discuss similarities and differences among programs for teaching thinking and the kinds of changes one can expect from the use of the programs.

Vygotsky, L. S. ***Thought and Language.*** **Cambridge, MA: Massachusetts Institute of Technology Press, 1962.** This is a classic book on thought processes and language development.

Wales, Charles, Anne Nardi, and Robert Stager. "Decision Making: New Paradigm for Education." ***Educational Leadership,*** **Vol. 44, May 1986, pp. 58-61.** The decision-making model involves four operations: state the goal, generate ideas, prepare a plan, and take action. At each operation, the process skills of analysis, synthesis, and evaluation are integrated. Each of the steps incorporates focus and a result.

Whimbey, Arthur, and Jack Lochhead. ***Problem Solving and Comprehension: A Short Course in Analytical Reasoning.*** **Philadelphia: Franklin Institute Press, 1982.** A course in analytical reasoning, emphasizing logical mathematical skills, is presented.

Williams, Frank. ***Classroom Ideas for Encouraging Ideas*** **. East Aurora, NY: D.O.K. Publishers, 1970.** Williams' model for implementing cognitive affective behaviors in the classroom incorporates three dimensions: the curriculum, teacher behaviors, and pupil behaviors. The 18 teaching strategies are illustrated with idea lessons at all grade levels.

Worsham, Antoinette, and Anita J. Stockton. ***A Model for Teaching Thinking Skills: The Inclusion Process.*** **Bloomington, IN: Phi Delta Kappa Educational Foundation, 1986.** The fastback describes a way to provide for the direct teaching of thinking skills within the context of the existing curriculum.

Staff Development Materials

These titles may be available from your area education agency or from the Cooperative Network of Inservice Resources, which serves AEAs 2, 3, 4, 5, 6, 7, 9, 12, 13, 14, 15, and 16. Contact CNIR at AEA 6 Media Center, 210 S. 12th Avenue, Marshalltown, Iowa 50158.

Cognitive Development

Cognitive Development **(sound filmstrip). Concept, 1975, 1 strip, 1 cas.** This filmstrip explores two major approaches to cognitive development: Piaget's theory through sensorimotor, preconceptual, and intuitive stages, and the examination of the basic cognitive processes involved in problem solving, including perception, memory, generation of hypotenuses, and evaluation.

Cognitive Development: Formal Thought **(sound filmstrip). Concept, 1977, 1 strip, 1 cas.** This filmstrip presents the characteristics of formal stage thought according to Piaget's theory of intellectual development. Discusses various views regarding the universality of formal stage thought and how it can be attained.

Disequilibrium: Unpredictability and Novel Change in Learning **(videotape). UDI, 1983, 30 min., 1/2 inch.** Wlodkowski demonstrates some of the teaching advantages in using unpredictability and disequilibrium to foster student motivation to learn.

Growth States of Learners **(videotape). TEA, 1983, 28 min., 1/2 inch.** Presents research-based descriptions and examples of the various states of learners' growth. Includes information on omnivores, active consumers, passive consumers, the resistant and the withdrawn.

***Piaget and Cognitive Growth* (videotape). Co. St. U., 1982, 29 min., 1/2 inch.** This program demonstrates the use of Piagetian tasks to assess and probe student thinking. It discusses the value of having this information, the improved understanding of why certain students are not learning, and why certain lessons will not work. It demonstrates the clinical interview, a valuable tool for probing the thinking of students and evaluating other assessments.

***Piaget's Develomental Theory—Classification* (film). Davidson, 1967, 17 min., color.** The developmental theory of Jean Piaget, Swiss child psychologist, is illustrated. Children are shown at several developmental stages, responding to tasks, each highlighting different mental operations essential to classification.

***Piaget's Developmental Theory—Conservation* (film). Davidson, 1967, 28 min., color.** Illustrates the developmental theory of Jean Piaget, showing children at several developmental stages, responding to tasks involving conservation of quantity, length, area and volume. Characteristics of thought from operational to formal are identified.

***Rhyme and Reason* (videotape). AIT, 1980, 29 min., 1/2 inch.** *Rhyme and Reason* explores cognitive development of young children—infant through pre-teens. Children are seen exploring their environments and building concepts from their discoveries in persistent, experimental play.

***What Do You Think?* (film). ACI, 1971, 34 min., color.** Demonstrates the three major stages of a child's cognitive development between the ages of 4 and 12. Shows a discussion with six children in which they reveal some of their concepts about the physical world, the moral world and the religious world.

Creative Thinking

***Consciousness and Creativity: Right-Brain Modes of Knowing* (audiotape). U.Cal., 1977, 2 cas., 30 min.** Mary Frances Claggett, chairperson of the English department in her California High School, offers an exploration of the use of dreamsharing, meditation, mandala-patterning, biorhythms, psychic sensitivity, and symbol systems in the classroom. These activities are used to enhance creativity, extend the boundaries of experience, and balance the learning process by enabling teachers and students to use both sides of the brain.

***Creative Thinking* (audiotape). Nightingale, 1982, 8 cas., 660 min.** These tapes offer a comprehensive creative philosophy that has been tested and proved on the firing line in hundreds of organizations. Challenges old approaches and sets new standards for a more dynamic, creative environment for making "good/bad," "right/wrong" value judgments, and for establishing a total communications system with your associates that works.

***Creative Thinking and Self-Directed Learning* (videotape). CFE, 1981, 102 min., 1/2 inch.** Dr. Treffinger explains the need for developing creativity and self-directed learning skills in students, and discusses techniques which can be used to develop these skills. Five different teaching styles are described, each involving different degrees of student participation in decision making. Treffinger believes that teachers should become aware of these styles so that they can move gradually toward the styles which foster the greatest degree of independence in the students.

***Creativity: The Only Way to Fly* (film). Salenger, 1982, 6 min., color.** Illustrates the three characteristics of creative people and three ways to encourage creativity: take risks, accept mistakes, and persistence. Explains that creative people help organizations increase productivity and solve major problems. Uses newsreel film clips to point out the need for organizations to draw upon and encourage what may be their most valuable resource: the creative person.

***Creativity: A Way of Learning* (sound filmstrip). NEA, 1973, 1 strip, 1 rec.** This strip explores just what creativity is, how it is related to life in and out of school, and how it can be encouraged.

***Creativity: Bridge Between Thinking and Feeling* (audiotape). Ed.Tech., 1971, 1 cas., 30 min.** Frank E. Williams defines the skills that seem to distinguish creative persons. He then discusses how teachers can nurture these skills in their students.

Knowledge as Design **(audiotape). ASCD, 1985, 2 sides, 60 min.** David Perkins explains how treating curriculum topics as designs could develop student creativity. One of a series of programs taped at a conference of the New York State ASCD where seven of the leading advocates of teaching thinking skills were featured speakers.

Metaphoric Thinking and Analogic Thought **(videotape). AIT, 1985, 27 min., 1/2 inch.** Using metaphors and analogies can help sudents read with understanding and write with clarity and imagination. Defines analogic and metaphoric thought; suggests ways in which teachers can foster analogic thought in the classroom; and shows how these types of thinking help students understand content better.

Slowly the Singing Began **(film). Media Guild, 1978, 23 min., color.** Michael Moos, a young poet, employs poetry to stimulate children's imagination and creativity. By having them listen to, read, and write poetry, he teaches them to trust themselves and to take risks with language, ideas, and feelings. Film shows how creative, intelligent, sensitive, and aware most children are.

Synectics **(videotape). TEA, 1983, 43 min., 1/2 inch.** A technique for creative problem solving through Synectics, (an instructional approach to the development of learner creativity), is demonstrated.

Synectics **(videotape). Colorado St., 1982, 29 min., 1/2 inch.** The tape covers assumptions about creativity, phases of synectics (teaching model requiring the active participation of the student); explains about relating the familiar to the unfamiliar, and relating the strange to the familiar. Demonstrates the use of synectics to develop creative or divergent thinking abilities in students.

Synectics **(videotape). AIT, 1984, 29 min., 1/2 inch.** This tape discusses the process of making the familiar strange and the strange familiar and demonstrates its use in a language arts classroom. Defines synectics, lists the types of analogies used in the synectics process, suggests the power of synectics for making students think creatively.

Total Creativity Program for Individualizing and Humanizing the Learning Process **(kit). Educ. Tech., 1972, 2 cas., 6 books, posters.** This program is designed to provide a more humane learning environment in all elementary school classrooms through the careful use of teaching strategies which recognize the distinctive creative abilities of each child. Components deal with identifying and measuring creative classroom ideas for encouraging thinking and feeling, thinking-feeling processes, and teaching strategies.

Decision Making—Reasoning

Formal Reasoning Patterns **(film). Dvdsn Film, 35 min.** This film shows students trying to think through four different problems. It explains the reasoning processes these students use and that the different processes are not learned in any particular order.

Helping Children Improve in Decision Making I: Six Steps to Making Satisfying Decisions **(film). Spec.Purp., 1978, 29 min., color.** Dr. Madeline Hunter identifies three types of decisions: 1) decisions which are to be made by an individual; 2) decisions which are to be made by a small group; and 3) decisions which are to be made by an authority figure. Includes classroom scenes where students are beginning to discriminate between situations in which they can and cannot make decisions.

Helping Children Improve in Decision Making II: Six Steps to Making Satisfying Decisions **(film). Spec.Purp., 1978, 29 min., color.** The three types of decisions and the critical concept of "under what conditions" do you make a decision by yourself and when do you seek assistance from others are reviewed. The criteria: 1) are you able to; 2) do you know how to; 3) are you willing to; and 4) is it safe to, are used to determine appropriate conditions for decision making by the individual, the group, and an authority. Dr. Madeline Hunter concludes by teaching six sequential steps in how to make a satisfying decision.

Helping Children Improve in Decision Making III: Feelings and Decision Making **(film). Spec. Purp., 1978, 29 min., color.** This film shows children making decisions in actual classroom settings. Dr. Madeline Hunter then points out the role and responsibility of schools in helping students acquire information and develop the skills necessary for making responsible and satisfying decisions.

Helping Children Improve in Decision Making IV: Information and Decision Making **(film). Spec. Purp., 1978, 29 min., color.** Dr. Madeline Hunter lectures to show the beginning stages of students using newly learned information to determine those decisions they should make by themselves and those situations where they should seek assistance.

Inquiry Teaching/Conceptual Approach

Conceptual Approach: A Demonstration in History **(videotape). AIT, 1985, 29 min., 1/2 inch.** This tape discusses the concepts of conceptual teaching and demonstrates anchoring the teaching of the broad concept of war in the experiences of fifth-grade students. It shows how to develop schematics for particular ideas included in a concept, defines a concept, and explains how to develop important concepts in a particular discipline.

Conceptual/Thematic Approaches **(videotape). AIT, 1985, 29 min., 1/2 inch.** Teaching with focal concepts—"curing disease"—in a science class and "nonconformity" in an English class are demonstrated. Viewers will be able to defend the use of conceptual and thematic approaches to teaching; identify important concepts or themes that could serve as the foci for subject matter teaching. Also suggests ways in which conceptual approaches are consistent with what is known about learning.

Facilitating Inquiry in the Classroom **(kit). N.W.R.E.L., 1973, 4 tapes, wkbks.** The kit provides the basis for a four-hour workshop. Themes are to identify, practice and gain skill in using interaction patterns that allow students to inquire, help students grow in their ability to learn independently, and reveal student attitudes about and perceptions of the inquiry process.

Inquiry Approach **(videotape). AIT, 1985, 29 min., 1/2 inch.** This demonstrates an inquiry exercise in science with ninth-grade students and discusses teaching and learning. It defines inquiry as a teaching methodology; identifies the five stages of the inquiry model; and connects inquiry methodologies to issues in scientific creativity.

Inquiry Training **(videotape). TEA, 1983, 30 min., 1/2 inch.** The technique of inquiry training with high school students is demonstrated. The tape covers the five phases of inquiry training: 1) confront a puzzling situation; 2) given information about an event or experience; 3) learners introduce new elements into the situation to see what effect they have on the situation; 4) learners formulate an explanation; and 5) learners analyze their own processes of inquiry.

Organizing Facts to Teach Meaningful Relationships **(film). Univ. of Colo., 1973, 14 min., color.** This film is intended to help teachers understand the composition of a strategy which enables a teacher to exert control over student learning of concepts, generalizations, and higher order knowledge.

Perception, Memory, Concept Attainment

Brain Power **(film). LCA, 1982, 11 min.** John Houseman involves the audience interactively with stimulating thoughts and visual brain-teasers. Solutions to the mental challenges reveal three key principles of perception: Recognition (pay attention to details); interpretation (tolerate a little ambiguity); and expectation (beware limiting expectations). Based on book Brain Power by Dr. Karl Albrecht. Designed to motivate groups to get out of meetings what they expect.

Concept Attainment **(videotape). TEA, 1983, 57 min., 1/2 inch.** Tape one presents a technique for teaching thinking skills through concept attainment. Tapes two and three present several demonstrations of conceptual attainment in a variety of settings. Explains the Reception Model and the Selection Model and when these models should be used.

Concept Attainment **(videotape). Colorado St., 1982, 29 min., 1/2 inch.** This tape looks at another information processing model applicable at all levels which allows teachers to analyze student thinking strategies as they try to uncover a particular concept. It requires active involvement, real problems to solve, and is not just memorization or practicing skills . . . and leads naturally to thinking about thinking—who thought of what and how and when and why?

Memory **(film). CRM, 1980, 30 min.** Memory explores human memory, including theories about its psychological and physiological operations and the practical application of memory systems. It includes information about ways of improving the ability to properly encode information for quick and efficient access.

Memory Model: A Demonstration **(videotape). TEA, 1983, 23 min., 1/2 inch.** This lecture/discussion of the sources and uses of alternative models of teaching helps viewers identify several ways in which information about models of teaching can be collected and reported.

Problem Solving

Bears, Monsters, and Frogs: An Approach to Problem Solving **(videotape). Sunburst, 1984, 30 min., 1/2 inch.** This tape discusses the what and why of teaching problem solving, offers suggestions on how to fit problem solving in the curriculum and demonstrates how to use problem solving courseware in subject areas.

Creative Problem Solving: How to Get Better Ideas **(film). McGraw, 1979, 27 min.** When creativity is rewarded, we have a significantly greater number of ideas. The group problem-solving technique called "brainstorming" is examined.

Creative Problem Solving **(audiotape). JAB, 1980, 3 cas., 270 min.** This tape helps define creativity, creative thinking, brainstorming, and problems as used in creative problem solving. Narration is taken from actual workshop situations.

Problem Solving and Decision Making **(videotape). AIT, 1985, 29 min., 1/2 inch.** This tape demonstrates using a computer simulation to help students develop decision-making skills and discusses problem solving. It explains the steps in Treffinger's problem-solving model and suggests ways in which problem solving can be used to learn content.

Problem Solving: The Basic Skill **(videotape). EPA, 1980, 40 min., 1/2 inch.** This tape focuses on practical suggestions for teaching a variety of problem solving processes and strategies, featuring five elementary school children applying these.

Research and Development: Interactive Computer Graphics for Intuitional Problem Solving **(videotape). NDN, 1983, 41 min., 1/2 inch.** The Xerox Palo Alto Research Center is devising a computer system which explores the possibility that the skillful use of dynamic graphics may bring about qualitative changes in the educational process. With this intent, Xerox has implemented a system for animating algebra word problems called TRIP that exercises the intuitional rather than the analytical aspect of problem solving. The system is demonstrated.

Teaching for Problem Solving in the Real World **(audiotape). ASCD, 1982, 120 min., 1/2 inch.** This tape shows how many thinking skills programs fail to reflect the complexity of thinking and problem solving in the world outside the classroom. From a series by seven of the leading advocates of teaching thinking taped at a conference of New York State ASCD.

Questioning Techniques

Effective Questioning—Elementary **(film). Far West, 1971, 11 films, 2 handbooks.** This set helps teachers learn and reinforce 12 specific skills that lead to active student involvement, higher thought processes, and a reduction in teacher talk in a classroom discussion. The set includes manuals, instructor's guides, films, and is to be used for a six-week inservice training program using microteaching.

Higher Cognitive Questioning **(film). Far West, 1971, 6 films, wkshts.** Trains intermediate and advanced level teachers to use 15 specific skills that focus on questioning as a basic instructional strategy for improving students' thinking abilities. These films are to be used as the basis for a six-week inservice microteaching training program. A preview package is available.

How to Ask Better Questions **(kit). Oregon T.C.,1976, 1 cas., script.** This workshop suggests many ways to use knowledge, comprehension, application, analysis, synthesis and evaluation questions with positive results.

Questioning Techniques for Teachers and Students **(filmstrip). NEA, 1984, 1 strip, 10 min.** This filmstrip explains to teachers how to pose more thought-provoking ideas, how to successfully use convergent/divergent and evaluative questions; and how to follow up with probing questions to clarify and expand the students' participation. It also covers the latest research findings on how to improve the quality and level of questions from students.

Questioning Skills **(film). Hubbard, 1977, 30 min.** Various levels of questioning and techniques for analyzing questions are provided. It also defines 12 thinking processes with guidelines for deductive and inductive reasoning and other similar skills such as interpreting, comparing, classifying, and synthesizing to promote understanding.

Questions for Thinking **(film). D.Bell, 1972, 28 min.** Learning and memorizing are what schools have always stressed, yet thinking is what we have to do the rest of our lives. Thinking is figuring out what to do when you don't know what to do. Schools should promote more thinking...and they can. Glasser expands on these thoughts.

Teaching Thinking—General

Approaches to Teaching Thinking **(audiotape). ASCD, 1985, 1 cas., 2 sides.** Taped at conference of the New York State ASCD, this program is one of a series of addresses by seven of the leading advocates of teaching thinking skills. Brandt compares several widely used approaches.

Classroom Conditions that Encourage Student Thinking **(audiotape). ASCD, 1985, 1 cas., 2 sides, 120 min.** One of a series of addresses taped at a conference of the New York State ASCD where seven leading advocates of teaching thinking skills were featured speakers, this program by Costa suggests ways teachers can stimulate thinking, including asking questions and responding appropriately to students.

Convergent Thinking: Analysis, Synthesis, and Evaluation **(videotape). AIT, 1985, 29 min., 1/2 inch.** Demonstrates classroom techniques for helping students reach higher levels of thought. Defines convergent thought and demonstrates the use of decision-making matrices in arriving at satisfactory answers to complex problems.

Divergent Thinking: Fluency, Flexibility, Originality, Elaborateness **(videotape). AIT, 1985, 29 min., 1/2 inch.** This tape discusses creativity and its possibilities and demonstrates the use of brainstorming and concept attainment strategies. It defines divergent thinking and describes affective requirements for divergent thought.

Extending Students' Thinking **(film). Spec. Pur., 1976, 30 min.** This easily understood presentation of the six levels of thinking from Bloom's taxonomy of the Cognitive Domain provides many practical examples of real classroom episodes, shows the usefulness of this taxonomy, and helps teachers develop critical and creative thinking in students. Lecture by Dr. Madeline Hunter.

Extending Their Thinking **(videotape). Inst. Dyn., 1982, 15 min., 1/2 inch.** Techniques for eliciting Bloom's six levels of cognition are described and illustrated in classroom episodes. The incremental nature of such thinking is stressed so comprehension becomes the launching pad for problem solving and creativity.

Giftedness in All Children **(videotape). EBEC, 1982, 27 min., 1/2 inch.** After viewing this program, teachers should be aware of how to improve techniques in creative questioning, develop activities for teaching both sides of the brain, implement methods of discovery and inquiry into classes, and share discovery-learning techniques.

Group Techniques for Enhancing Thinking **(videotape). Univ. Wi., 1985, 29 min., 1/2 inch.** This tape demonstrates two kinds of brainstorming—force-field and the "fish bowl" technique. It identifies several group discussion techniques which develop skill in thinking in groups, lists the qualities of brainstorming, and identifies roles played by members of task groups.

Improving Teaching **(videotape). IDEA, 1984, 35 min., 1/2 inch.** One of four presentations made by Gordon Cawelti at the I/D/E/A Special Fellows Institute on "Critical Issues in Education—

The American High School," this presentation includes information about TESA (Teacher Effectiveness-Student Achievement), the Hunter Instructional Model, teacher effectiveness, learning styles, teaching for higher order thinking skills, and teaching strategies in the content areas.

Improving the Quality of Student Thinking **(videotape). ASCD, 1984, 36 min., 1/2 inch.** This tape suggests 10 ways to improve the quality of student thinking, K-12, and includes classroom episodes in which teachers ask open questions, follow up student responses, and model other suggested practices.

Inductive Thinking **(videotape). CO. St. U., 1982, 29 min., 1/2 inch.** The information processing model (involving the organization and interpretation of data and the application of principles) is explained, along with how using it helps students in organizing their thinking strategies, and consequently approach problems from logical rather than haphazard viewpoints.

Learning About Thinking and Vice Versa **(film). Film Bureau, 1972, 32 min., b/w.** This film about how teachers can learn more about children's thinking is designed primarily for use in in-service sessions. The central theme is that teachers can benefit by spending time questioning children in one-to-one situations and that in this way they can better perceive the nature of the difficulty in understanding the child's actions and in making themselves understood by the children.

Learning: A Matter of Style **(videotape). ASCD, 1979, 50 min., 1/2 inch.** An introductory resource that explains learning style, this tape develops initial diagnostic and prescriptive skills, provides basic materials to help apply this knowledge, and suggests sources for additional information.

Objectives in the Cognitive Domain **(film). Sp. Purpose, 1970, 30 min., b/w.** Dr. Madeline Hunter teaches the six levels of Bloom's Taxonomy of Educational Objectives. Classroom examples for each level are cited in several subject areas. Relationship of behavioral objectives to problem solving, critical thinking, and the higher cognitive processes is described. The importance of this taxonomy to individualization of instruction is demonstrated with examples of use in daily teaching.

Practice is not Enough **(audiotape). ASCD, 1985, 1 cas., 120 min.** This tape introduces suggestions for incorporating thinking skills into regular academic course work and teaching them directly. One of a series of addresses by seven of the leading advocates of teaching thinking in the schools, taped at a conference of the New York State ASCD.

Teaching Skillful Thinking: Staff Development Program for Educators **(videotape). ASCD, 1986, 103 min., 1/2 inch.** This videotape is designed to help faculty initiate a serious study of methods that promote skillful thinking in the classroom. Topics include: Issues in Teaching Thinking (summarizes data about the need for teaching thinking and examines what researchers and developers mean by thinking skills and best approaches to teaching them); Skillful Thinker (asks viewers to consider attributes of good thinkers, presents various viewpoints on qualities of skillful thinkers, and explains the kinds of experiences people need to become better thinkers); Teaching for Thinking (describes teacher behaviors that promote skillful thinking—welcoming divergent views, asking open-ended questions, providing time for discussion as well as recitation); Teaching Of and About Thinking (covers explicit instruction in selected thinking skills and covers development of metacognition—awareness of what one does or doesn't know and the ability to monitor one's own thinking).

Teaching Reading as Thinking **(videotape). ASCD, 1985, 30 min., 1/2 inch.** Current theory and research on reading comprehension are translated into a practical instructional model for classroom use. Features noted researchers and program developers who explain a fresh conception of the reading process and demonstrate recommended strategies in actual classroom scenes. Covers a model that links reading process to instruction before, during and after reading; concrete examples of how to apply the model; and an in-depth treatment of four specific instructional strategies. Manual includes transparency masters and hand-outs for inservice use.

***Teaching to Develop Independent Learners, Part III (4-8 Year Olds)* (film). Spec. Purp., 1979, 29 min., color.** Viewers observe the same students from part I two months later. Now these students are at the second stage of independence and are able to direct their own new and creative learning. In a regular classroom setting, young learners demonstrate their ability to be in charge of themselves as they move throughout the school, engage in group research projects, record findings and report results—all without direct teacher supervision. Flashbacks to the first days of school show the intensive and skilled teaching which achieves this degree of student independence. Dr. Madeline Hunter summarizes the skills which must be taught in order to foster independent learning and suggests many practical techniques for use in the viewer's own classroom.

***Thinking as a Skill* (audiotape). ASCD, 1985, 1 cas., 120 min.** One of a series of talks taped at a conference of the New York State ASCD where seven leading advocates of teaching thinking skills were featured speakers, this tape argues that thinking is a skill that should be given direct attention in schools.

***Thinking Skills* (sound filmstrip). Benefic, 1978, 1 cas., guide.** This program is designed to help teachers become more successful in teaching for thinking. Titles included are: Developing thinking skills; Responses that promote thinking.

***Thinking, Writing, and Reading* (film). Media Five, 1976, 29 min., color.** Kohl, Hunter, and others examine the case for the total-language approach emphasizing the thinking-speaking-reading-writing continuum. Documentary scenes illustrate the importance of personalized writing to the whole of language experience.

Appendices

APPENDIX A
Incorporating Higher Order Thinking in Curricular Areas

List the thinking skills/processes selected by your school district. Check the curricular areas where a specific process will be emphasized. Each skill/process should be emphasized consistently in a number of areas.

	Arts	Foreign Language	Health/Physical Ed.	Language Arts	Mathematics	Science	Social Studies	Vocational Education

Source: Burklund, Garvin, Lawrence, Yoder.

List the thinking skills/processes selected by your school district. Check the curricular areas where a specific process will be emphasized. Each skill/process should be emphasized consistently in a number of areas.

	Thinking Skills/Processes	Arts	Foreign Language	Health/Physical Ed.	Language Arts	Mathematics	Science	Social Studies	Vocational Education
Critical Thinking	Analyzing: recognizing patterns								
	classifying								
	identifying assumptions								
	identifying the main ideas								
	finding sequences								
	Connecting: comparing/contrasting								
	logical thinking								
	inferring deductively								
	inferring inductively								
	identifying causal relationships								
	Evaluating: assessing information								
	determining criteria								
	prioritizing								
	recognizing fallacies								
	verifying								
Creative Thinking	Synthesizing: analogical thinking								
	summarizing								
	hypothesizing								
	planning								
	Imagining: fluency								
	predicting								
	speculating								
	visualizing								
	intuition								
	Elaborating: expanding								
	modifying								
	extending								
	shifting categories								
	concretizing								

Source: Burklund, Garvin, Lawrence, Yoder.

(continued)

APPENDIX A, cont.

Complex Thinking Processes — Thinking Skills/Processes	Arts	Foreign Language	Health/Physical Ed.	Language Arts	Mathematics	Science	Social Studies	Vocational Education
Problem Solving								
Decision Making								
Designing								

APPENDIX B
Scope and Sequence Within a Discipline or Grade Level

Select thinking skills/processes appropriate to the discipline and grade level of the learners. Check whether the thinking skills are evident in the written curriculum, taught curriculum, student behaviors, or evaluation process.

_____
Discipline

Grade Levels	Thinking Skills/Processes	Written Curriculum	Taught Curriculum	Student Behaviors	Evaluation Processes

Source: Burklund, Garvin, Lawrence, Yoder.

Select thinking skills/processes appropriate to the discipline and grade level of the learners. Check whether the thinking skills are evident in the written curriculum, taught curriculum, student behaviors, or evaluation process.

Discipline _____

	Grade Levels	Thinking Skills/Processes		Written Curriculum	Taught Curriculum	Student Behaviors	Evaluation Processes
Critical Thinking		Analyzing:	recognizing patterns				
			classifying				
			identifying assumptions				
			identifying the main ideas				
			finding sequences				
		Connecting:	comparing/contrasting				
			logical thinking				
			inferring deductively				
			inferring inductively				
			identifying causal relationships				
		Evaluating:	assessing information				
			determining criteria				
			prioritizing				
			recognizing fallacies				
			verifying				
Creative Thinking		Synthesizing:	analogical thinking				
			summarizing				
			hypothesizing				
			planning				
		Imagining:	fluency				
			predicting				
			speculating				
			visualizing				
			intuition				
		Elaborating:	expanding				
			modifying				
			extending				
			shifting categories				

Source: Burklund, Garvin, Lawrence, Yoder.

(continued)

APPENDIX B, cont.

Discipline _____

	Grade Levels	Thinking Skills/Processes	Written Curriculum	Taught Curriculum	Student Behaviors	Evaluation Processes
Creative Thinking		Elaborating concretizing				
		Problem Solving				
Complex Thinking Processes		Decision Making				
		Designing				

Source: Burklund, Garvin, Lawrence, Yoder.

APPENDIX C
A Thinking Skills Checklist
Barry K. Beyer

	Yes	*In Progress*	*No*
1. *Does your school system have:*			
a. A list of major thinking skills to be taught throughout the system?	_____	_____	_____
b. Agreement among all subject areas that these skills should be taught throughout the system?	_____	_____	_____
c. A K-12 curriculum document that clearly delimits which thinking skills are to be taught at each grade level in each subject area?	_____	_____	_____
d. A K-12 curriculum document that presents thinking skills to be taught in a developmental sequence based on the cognitive development of learners, nature of the target skills, and subject-matter needs?	_____	_____	_____
e. A thinking skills curriculum that provides for continuing instruction in these thinking skills across many grade levels and subjects?	_____	_____	_____
f. Detailed descriptions of the operating procedures, rules, and distinguishing criteria of each major thinking skill or process skill to be taught?	_____	_____	_____
g. Appropriate thinking skill descriptions in the immediate possession of every teacher and administrator?	_____	_____	_____
h. Provisions for instruction in each skill with a variety of media, in a variety of settings, and for a variety of goals?	_____	_____	_____
2. *Do your teachers:*			
a. Use a common terminology and instructional language to describe the thinking skills they are required to teach?	_____	_____	_____
b. Provide instruction in thinking skills when these skills are needed to accomplish subject-matter learning goals?	_____	_____	_____
c. Understand the major components of the thinking skills they are teaching?	_____	_____	_____
d. Provide continuing instruction in each thinking skill through the stages of readiness, introduction, guided practice, extension, practice and application?	_____	_____	_____
e. Introduce thinking skills as explicitly as possible by explaining and modeling each skill and having students apply the skill with their guidance?	_____	_____	_____

APPENDIX C, cont.

	Yes	*In Progress*	*No*
f. Provide frequent, guided practice in each skill with appropriate instructive feedback?	_____	_____	_____
g. Require students to reflect on and discuss how they made each skill operational?	_____	_____	_____
h. Use instructional materials appropriate to learning thinking skills?	_____	_____	_____
i. Test on their own unit tests the thinking skills they are responsible for teaching?	_____	_____	_____
3. *Do your provisions for evaluating the learning of thinking skills include the:*			
a. Selection and development of instruments that measure student performance on skills taught in the school system?	_____	_____	_____
b. Use of instruments that are valid measures of thinking skill competency?	_____	_____	_____
c. Use of instruments that provide the maximum data for diagnostic or monitoring purposes?	_____	_____	_____
4. *Do your supervisors and instructional leaders:*			
a. Understand the nature of the thinking skills and how to teach and measure them?	_____	_____	_____
b. Provide inservice instruction in the nature of the thinking skills to be taught and in different ways to teach these skills?	_____	_____	_____
c. Help teachers in different subject areas and grade levels share methods for teaching thinking skills?	_____	_____	_____
d. Ensure that teachers follow the thinking skills curriculum?	_____	_____	_____
e. Ensure the revision of the thinking skills curriculum, instructional strategies, and instructional materials as appropriate?	_____	_____	_____

(Costa, 1985. *Developing Minds*, p. 319-21)

APPENDIX D
Classroom Observation Checklist
S. Lee Winocur

Teacher_____ School_____ District_____

Observer_____ Subject_____ Date_____

Directions:

Mark an "x" in the appropriate column for each classroom behavior. If the statement is generally true of this classroom, mark *yes*. If the statement is generally not true of this classroom, mark *no*. If you are unsure, mark the third column.

	Yes	*No*	*Unsure*
Affective Disorders			
1. Fosters a Climate of Openness			
• Eye contact is frequent between teacher and students, and students and students.	_____	_____	_____
• Teacher moves around the room.	_____	_____	_____
• Students listen attentively to others.	_____	_____	_____
• Teacher calls on students by name.	_____	_____	_____
2. Encourages Student Interaction/Cooperation			
• Students work in pairs or small groups.	_____	_____	_____
• Students respond to other students.	_____	_____	_____
• Students help others analyze and solve problems.	_____	_____	_____
3. Demonstrates Attitude of Acceptance			
• Teacher accepts all valid student responses.	_____	_____	_____
• Incorrect student responses elicit encouraging, supportive comments.	_____	_____	_____
• Teacher acknowledges student comments with a nod or other signal.	_____	_____	_____
Cognitive Indicators			
4. Encourages Students to Gather Information			
• Reference materials are readily available.	_____	_____	_____
• Students use reference materials.	_____	_____	_____
• Student mobility is allowed to obtain information.	_____	_____	_____
• Teacher acts as facilitator.	_____	_____	_____
• Students record data in notebooks or journals.	_____	_____	_____
5. Encourages Students to Organize Information			
• Teacher works from organized lesson plans.	_____	_____	_____
• Students classify and categorize data.	_____	_____	_____
• Students take notes systematically.	_____	_____	_____
• Teacher's presentation is logical, organized.	_____	_____	_____
• Ideas are graphically symbolized during instruction.	_____	_____	_____
6. Encourages Students to Justify Ideas			
• Teacher probes for correct responses.	_____	_____	_____
• Teacher seeks evidence for stated claims.	_____	_____	_____
• Students analyze sources of information for reliability, relevance.	_____	_____	_____
• Teacher frequently asks, "Why do you think so?"	_____	_____	_____
• Students relate learning to past experience or similar situations.	_____	_____	_____

		Yes	*No*	*Unsure*
7.	Encourages Students to Explore Alternatives and Other's Points of View			
	• Teacher establishes expectations for divergent solutions.	_____	_____	_____
	• Teacher allows time to consider alternatives/points of view.	_____	_____	_____
	• More than one student is queried for point of view/solution.	_____	_____	_____
	• Teacher asks students to justify and explain their thoughts.	_____	_____	_____
8.	Asks Open-Ended Questions			
	• Teacher asks open-ended questions with multiple answers *as frequently* as single-answer questions.	_____	_____	_____
9.	Provides Visual Cues for Developing Cognitive Strategies			
	• Teacher appropriately uses a variety of visual media (charts, chalkboard, maps, pictures, gestures).	_____	_____	_____
	• Teacher uses symbolic language to illustrate a point (simile, metaphor).	_____	_____	_____
	• Teacher uses outlining.	_____	_____	_____
10.	Models Reasoning Strategies			
	• Teacher uses "if/then" language.	_____	_____	_____
	• Teacher poses "what if" or "suppose that" questions.	_____	_____	_____
	• Teacher uses clear examples to facilitate logical thought.	_____	_____	_____
11.	Encourages Transfer of Cognitive Skills to Everyday Life			
	• Teacher encourages transfer at end of lesson with comments like, "This will help you in your everyday life in this way..."	_____	_____	_____
12.	Elicits Verbalization of Student Reasoning			
	• Teacher poses questions at different levels of Bloom's Taxonomy.	_____	_____	_____
	• Teacher allows at least ten seconds wait time for student answer before restating or redirecting the question.	_____	_____	_____
	• Teacher asks students to clarify and justify their responses.	_____	_____	_____
	• Teacher probes "I don't know" responses.			
	• Teacher reinforces students for responding to open-ended questions.	_____	_____	_____
13.	Probes Student Reasoning for Clarification			
	• Teacher asks questions to elicit reasoning by students.	_____	_____	_____
	• Teacher requires students to expand on answers.	_____	_____	_____
	• Teacher cues students for most logical answers.	_____	_____	_____
14.	Encourages Students to Ask Questions			
	• Teacher poses problematic situations.	_____	_____	_____
	• Teacher withholds "correct" responses; encourages students to explore possibilities.	_____	_____	_____
	• Teacher encourages students to answer other students' questions.	_____	_____	_____
15.	Promotes Silent Reflection of Ideas			
	• Teacher allows time for reflection.	_____	_____	_____

(Costa, 1985. *Developing Minds*, p. 322-24)

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APPENDIX E

Self-Reflection on Your Teaching: A Checklist

John Barell

Using a scale of 1 to 5, rate your classroom and school according to the following items.

5 = Very Often 4 = Often 3 = Sometimes 2 = Seldom 1 = Hardly Ever

Classroom

1.	When students pose unusual or divergent questions, I ask, "What made you think of that?"	5	4	3	2	1
2.	Whatever the text says is accepted as the right answer.	5	4	3	2	1
3.	When a decision has to be made between involving the class in a discussion of an intriguing student idea (topic related) or moving on to "cover" content, I choose the latter.	5	4	3	2	1
4.	I encourage students to seek alternative answers.	5	4	3	2	1
5.	Students give reasons for making statements.	5	4	3	2	1
6.	I use subject matter as a means for students to generate their own questions (or problems), which we then seriously consider.	5	4	3	2	1
7.	When teaching, I sit or stand behind my desk.	5	4	3	2	1
8.	Most qustions posed during class can be answered with short or one-word answers.	5	4	3	2	1
9.	Students spontaneously engage in critiquing each other's thinking.	5	4	3	2	1
10.	Students relate subject matter to experiences in other subjects or in their personal lives.	5	4	3	2	1
11.	I stress *what* to think, not *how*.	5	4	3	2	1
12.	Students often set objectives for their own learning.	5	4	3	2	1
13.	Students spend time working collaboratively to solve subject matter questions.	5	4	3	2	1
14.	One focus in my classroom is trying to understand how and why people (mentioned in texts) created ideas, solutions, experiments, rules, principles, and so on.	5	4	3	2	1
15.	My classroom mirrors the patterns of involvement practices in most faculty meetings.	5	4	3	2	1
16.	Students actively listen to each other.	5	4	3	2	1

School

17.	We talk about the nature of thinking.	5	4	3	2	1
18.	My school stresses collaborative instructional problem solving.	5	4	3	2	1
19.	I learn from my colleagues by observing their teaching.	5	4	3	2	1
20.	My supervisor and I discuss how to challenge students to think in more complex fashion.	5	4	3	2	1

(Costa, 1985, *Developing Minds*, p. 315-16)

APPENDIX F

How Thoughtful Are Your Classrooms?

Arthur L. Costa

Using the following 14 questions as your criteria, rate your school's effectiveness in developing thinking skills.

		Degree of Effectiveness				
		(5 = high				*1 = low)*
1.	Do your community and staff value thinking as a primary goal of education?	5	4	3	2	1
2.	Does the staff believe that with appropriate intervention human intelligence can continue to grow throughout life?	5	4	3	2	1
3.	Have you reached consensus on or adopted a model of intellectual functioning?	5	4	3	2	1
4.	Are students aware that intelligent behavior is an instructional objective?	5	4	3	2	1
5.	Does the teachers' language (questioning and structuring) invite students to think?	5	4	3	2	1
6.	Do the teachers' response behaviors extend and maintain higher levels of thinking?	5	4	3	2	1
7.	Are learning activities arranged in order of increasing complexity and abstraction?	5	4	3	2	1
8.	Do instructional materials support higher cognitive functioning?	5	4	3	2	1
9.	Is adequate instructional time devoted to thinking?	5	4	3	2	1
10.	Does instruction provide for differences in modality strengths?	5	4	3	2	1
11.	Are concepts and problem-solving strategies encountered repeatedly throughout, across, and utside the curriculum?	5	4	3	2	1
12.	Do students and teachers discuss their thinking (metacognition)?	5	4	3	2	1
13.	Do evaluation measures assess intelligent behavior?	5	4	3	2	1
14.	Do significant adults model intelligent behaviors?	5	4	3	2	1

(Costa, 1985. *Developing Minds*, p. 317-18)

Classroom Observation Form

John Barell

This form has been developed using the most recent research on teacher effectiveness as it relates to improving students' complex thinking processes in the classroom.

Generic Teaching Methods

1. Sets high standards:
   - •Expects students to think with complexity and creativity.
   - •Models desired thinking skills in day-to-day conduct.
2. Structures the classroom for thinking:
   - •Organizes the classroom with clearly delineated rules for managerial and academic tasks.
   - •Informs students that thinking is the objective.
   - •Organizes the class for individual, paired, small-group, or total-group interaction.
   - •Communicates desired attitudes and behaviors to students, including specific objectives for thinking processes.
   - •Models thinking processes for students verbally.
3. Presents complex problems for students to think about:
   - •Provides rationale for new skill/concept being introduced.
   - •Provides meaningful examples, models, and comparisons.
   - •Relates new information to previously learned material and students' own experiences.
   - •Poses questions at various cognitive levels.
4. Establishes a warm, supportive environment for risk-taking:
   - •Encourages autonomy of thought and action.
   - •Encourages peer listening and responsive interaction.
   - •Accepts students' contributions nonjudgmentally.
   - •Uses silence (wait time) effectively.
   - •Probes for clarification, extension, or expansion of meaning
   - •Probes for clarification of process (metacognition)—"How did you arrive at your conclusion?"
   - •Builds on and extends students' responses.
   - •Encourages trust and cooperative behavior.
   - •Provides an environment rich in data sources.
   - •Responds with information when the student needs or requests it.
   - •Identifies students' cognitive functions.

(Costa, 1985, *Developing Minds*, p. 314)

APPPENDIX G
Glossary

Note: This glossary is a compilation of definitions used in this guide. More general glossaries can be found in *Dimensions of Thinking* and *Developing Minds.*

Argument: A line of logical reasoning consisting of a claim and reasons for accepting the claim.

Accepted Knowledge: The type of knowledge characteristic of the content/basic thinking province; facts, concepts, principles, and skills absorbed and recalled from content teaching and from general socialization.

Analyzing: Thinking that examines part/whole relationships in order to clarify understanding; includes recognizing patterns, classifying, identifying assumptions, identifying main ideas, and finding sequences.

Complex Thinking Processes: Multi-step processes such as problem solving, designing, and decision making which combine content/basic thinking, critical thinking, and creative thinking to achieve some end.

Connecting: Thinking that constructs relationships between statements, concepts, principles, facts, systems, and other wholes or parts; includes logical thinking, inductive inferring, comparing/contrasting, and identifying causal relationships.

Content: What is taught in the curricular areas.

Content/Basic Thinking: The skills of absorbing and recalling content to produce accepted knowledge and the metacognitive skills of knowledge and control of self and task.

Creative Thinking Skills: Those skills that produce generated knowledge by synthesizing, imagining, and elaborating accepted and reorganized knowledge.

Critical Thinking Skills: Those skills that produce reorganized knowledge by analyzing, connecting, and evaluating accepted and generated knowledge.

Directive Instruction: Teaching a thinking skill by first defining it for the students, then demonstrating it, and then leading students in guided and independent practice of the skill.

General Strategies: Broad teaching strategies that encourage students to engage in higher order thinking, such as thoughtful questioning, choosing texts, assignments, and tests that require critical, creative, and complex thinking, modeling thinking, and creating a classroom climate that respects student thinking. These strategies are the basis of the holistic approach and are also required in explicit skills-based instruction.

Generated Knowledge: The type of knowledge characteristic of creative thinking; concepts, principles, systems, etc., new to the thinker or objectively original.

Elaborating: Thinking that builds on existing ideas or knowledge by modifying, extending, expanding, shifting categories, and making abstractions concrete.

Evaluating: Thinking that makes judgments that are based on criteria; the skills include defining criteria, prioritizing, assessing information, recognizing fallacies, and verifying.

Explicit Skills Instruction: Teaching thinking by breaking it into skills that are defined and taught to students in specific skill development lessons.

Holistic Approach: Teaching thinking by providing encouragement and many opportunities for students to think; does not require defining thinking processes in detail.

Imagining: Thinking that uses mental imagery to stretch beyond the factual and logical in order to generate new ideas.

Inductive Lesson: Teaching a thinking skill by first naming it, then asking students to perform it, followed by a debriefing discussion which will lead to a teacher/student developed definition of the skill.

Metacognition: Basic thinking skills that enable people to learn and to do higher order thinking; the knowledge of the skills and attitudes necessary to control oneself and accomplish tasks.

Synthesizing: Thinking that combines known elements to make a new whole; include analogical thinking, summarizing, hypothesizing, and planning.

Reorganized Knowledge: The type of knowledge characteristic of critical thinking; produced by analyzing, connecting, and evaluating accepted or generated knowledge.

APPENDIX H
Classroom Materials and Resources

Building Thinking Skills. Midwest Publications, P.O. Box 448, Pacific Grove, CA 93950. The books are designed for various grade levels, 2-8; the teacher's manuals include discussion guidelines as well as explanations of the activities.

Cognitive Research Trust (CoRT). Pergamon Press, Fairview Park, Elmsford, NY 10523. Developed by Edward deBono, the teacher's handbook and student exercises provide for the teaching and practice of creative and other cognitive skills.

Comprehensive School Mathematics Program. Claire Heidema, 470 N. Kirkwood, St. Louis, MO 63122. An experiential approach to teaching mathematics by a spiral curriculum for grades K-6.

CPS: Creative Education Foundation. D.O.K. Publishers, 71 Radcliff Road, Buffalo, NY 14214. These exercises, designed for all grades and ability levels, focus on finding data, defining problems, finding ideas, finding solutions, and finding acceptance.

Critical Analysis and Thinking Skills. CATS Program, 4988 Kalani Drive, Salt Lake City, UT 84117-6421. CATS can be taught as a separate high school course or integrated into high school social studies for a semester.

Critical Thinking Handbooks. Sonoma State University, Center of Critical Thinking and Moral Critique, Rohnert Park, CA 94928. These two handbooks for grades K-3 and 4-6 are designed to empower teachers to remodel their own lesson plans in science, social studies, and language arts.

Critical Thinking I and II. Midwest Publications, Pacific Grove, CA. These secondary level materials on logic can be integrated in social studies and English.

Future Problem Solving Program. St. Andrews College, Laurenberg, NC 28352. Students are taught the steps of problem solving which they apply to problems of the future. They work in small groups and submit their problems and solutions to a state or national office for feedback. In addition to problem-solving skills, students develop written and verbal communication skills.

Institute for Creative Behavior. Educational Improvement Center, Box 209, Rt. 4, 207 Delsea Drive, Sewell, NJ 08080. The I.C.E. materials include exercises using imagery, sensory awareness, brainstorming, relaxation, analogy, etc. May be used at any grade level and with any ability level.

Instrumental Enrichment. University Park Press, 300 N. Charles Street, Baltimore, MD 21201. Reuven Feuerstein's materials help to develop student awareness of the learning process. Students analyze figurative problems and discuss problem solving to learn the process.

Learning to Learn. Box 493, Cambridge, MA 02138. Marcia Heiman has designed these learning strategies for junior/senior high students to encourage thinking in the content areas.

Odyssey of the Mind. Odyssey of the Mind, P.O. Box 27, Glassboro, NJ 08028. A creative problem-solving program for students K-12. A unique approach that actively engages students in using their knowledge, skills, and imagination to solve hands-on, real-life, practical problems.

Odyssey: A Curriculum for Thinking. Mastery Education Corporation, 85 Main Street, Watertown, MA 02172. A team of researchers at Harvard University developed six teacher manuals and student books which include: foundations of reasoning, understanding language, verbal reasoning, problem solving, decision making, and inventive thinking for middle level students.

Philosophy for Children. Montclair State College, Upper Montclair, NJ 07043. Novels with inquisitive children as characters are read and discussed using planned discussion and exercises. Topics include reasoning about nature, logic, ethics, aesthetics, and social institutions.

Project Impact. Orange County Superintendent of Schools, P.O. Box 9050, Costa Mesa, CA 92626. Lesson plans for teachers and student activities are designed for secondary school students.

Structure of Intellect. 343 Richmond Street, El Segundo, CA 90245. Using Guilford's Structure of the Intellect, Drs. Mary and Robert Meeker designed an individual assessment which provides the basis for diagnostic/prescriptive remediation and enrichment. Exercises are included and can be used with all grade levels.

TACTICS. Association for Supervision and Curriculum Development, 125 N. West Street, Alexandria, VA 22314-2798. Twenty-three strategies developed by Robert Marzano and Daisy Arredondo are presented for the educator to systematically integrate the teaching of thinking in the regular curriculum.

Talents Unlimited. NDN Project, 1107 Arlington Street, Mobile, AL 36605. Six talent areas are carefully developed for teacher training to be transferred to the classroom. Expanded from elementary and secondary.

THINK Program. Innovative Sciences, Inc., P.O. Box 15129, Stamford, CT 06901. The THINK Program includes media kits and student workbooks for elementary through high school both content-related and extra-disciplinary.